

In-Situ Thermal Treatment Pilot Test Results, Operable Unit 8, American Cyanamid Superfund Site, Bridgewater, NJ

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DATE: September 19, 2014

Introduction

As part of the Focused Feasibility Study (FFS) for Operable Unit 8 (OU8) (i.e., Impoundments 1 and 2) at the American Cyanamid Superfund Site in Bridgewater, New Jersey (Site), a field-scale pilot study was performed, on behalf of Wyeth Holdings LLC, between August 2013 and July 2014 evaluating two technologies for treating the acid tar within the impoundments. This memorandum summarizes results from the in-situ thermal treatment (ISTT) portion of the pilot study, one of the two technologies evaluated. In-situ stabilization/solidification (ISS) and a combination of ISTT and ISS also were evaluated during the pilot study; however, this memorandum only presents the ISTT results. Pilot study results summarizing the ISS portion of the pilot study are presented separately.

The pilot study focused on acid tar materials within Impoundment 2, which are the residual byproduct of manufacturing benzene, toluene, xylenes, and naphthalene from coal light oil during the 1940s through 1960s. The acid tar is characterized by a low pH (average of 1.5 standard units [SU]) and high concentrations of volatile organic compounds (VOCs), primarily benzene, and semivolatile organic compounds (SVOCs), as well as residual acidity. In addition, a suite of hazardous and malodorous compounds including hydrogen sulfide, sulfur dioxide, mercaptans, and carbon disulfide also are present in the material. The acid tar also has distinct physical properties, with two types of material; the viscous rubbery (VR) material is viscous and stringy and the hard and crumbly (HC) material is hard and fibrous. The pilot study was conducted in the northeastern portion of Impoundment 2, which was chosen based on the relatively equal proportions of VR and HC in this area. The contents of Impoundment 2 are similar to that in Impoundment 1, except Impoundment 2 has a higher proportion of VR material and Impoundment 1 has some inert composition from past remediation attempts.

ISTT Pilot Study Background

The pilot study program was developed using results of extensive laboratory testing performed in 2012 and 2013, which evaluated the potential effectiveness of ISTT and ISS on the acid tar within Impoundments 1 and 2. Using the laboratory findings, a pilot study was developed to evaluate potential implementability of ISTT, ISS, and a combination of the two technologies in the field. The pilot study, detailed in the *100 Percent Design of Pilot Study for Operable Unit 8* (CH2M HILL 2013a), was approved by the U.S. Environmental Protection Agency (USEPA) on December 12, 2013. In addition, a number of supporting documents were developed for the pilot study, including:

- *Technical Memorandum Soil Erosion and Sediment Control Plan for Operable Unit 8 Pilot Study* (CH2M HILL 2013b) – Approved by USEPA on August 1, 2012
- *Health and Safety Plan, American Cyanamid Superfund Site, Impoundments 1 and 2, In-Situ Thermal Treatment and In-Situ Stabilization and Solidification, Pilot Study for Operable Unit 8* (CH2M HILL 2013c) – Approved by USEPA on September 12, 2013

- *Waste Management Plan for Operable Unit 8 Impoundments 1 and 2 Pilot Study* (CH2M HILL 2013d) – Approved by USEPA on September 12, 2013
- *Quality Assurance Project Plan Pilot Study for Operable Unit 8* (CH2M HILL 2013e) – Approved by USEPA on November 14, 2013
- *Sampling and Analysis Plan for Operable Unit 8 Pilot Study* (CH2M HILL 2013f) – Approved by USEPA on November 14, 2013
- *Perimeter Air Monitoring Plan for Operable Unit 8 Pilot Study* (CH2M HILL 2013g) – Approved by USEPA on November 14, 2013
- *100 Percent Design of Pilot Study for Operable Unit 8* (CH2M HILL 2013a) – Approved by USEPA on December 12, 2013
- *Site-Specific Work Plan In-Situ Thermal Treatment and In-Situ Stabilization and Solidification* (CH2M HILL 2013h) – Approved by USEPA on December 12, 2013
- *Addendum to Flood Emergency Procedures Plan Impoundments 1 and 2 Pilot Study for Operable Unit 8* (CH2M HILL 2013i) – Approved by USEPA on December 12, 2013
- *Emergency Preparedness and Contingency Plan* (CH2M HILL 2013j) – Approved by USEPA on January 9, 2014

The pilot study commenced in August 2013 with initial activities involving the construction of infrastructure to support the treatment systems. An elevated platform (bench) was constructed along the western side of Impoundment 2 where the treatment equipment was placed to protect it from potential flooding. A floating platform (Flexifloat) was deployed on top of the water surface of Impoundment 2 and anchored using helical screws installed into the subgrade just beyond the outer base of the impoundment berms. This anchoring system was designed to secure the platform against flooding and high, hurricane force winds. The Flexifloat platform was used to suspend three 7-foot-diameter steel caissons with a 9-foot-diameter outer vapor collection shroud, which were placed through the existing water cap and into the impoundment materials. The caissons extended down to the identified clay layer underlying the impoundment materials to limit the influx of water and untreated tar into the test cell during treatment. Technologies evaluated in each caisson were:

- Caisson 1 - ISS only
- Caisson 2 – ISTT only
- Caisson 3 - ISTT followed by ISS

This memorandum covers the results of the testing within Caisson 2 (thermal only) and the results of the ISTT portion of the study in Caisson 3.

The caissons were fitted with a 9-foot-diameter outer shroud that extended through the existing water cap and into the impoundment materials. This shroud was installed to capture and mitigate potential fugitive emissions from outside the caisson during heating. Each caisson was fitted with a vacuum tight cover, which was used to support heating, extraction, and monitoring equipment (i.e., heater wells, thermocouples, vapor extraction wells, etc.). The cover also allowed for vapor capture within the headspace of the caisson so the vapor could be safely conveyed to a vapor treatment train. Figure 1 illustrates the configuration of the caisson, outer shroud, and cover used during the ISTT portion of the pilot study.

Heating was performed using electric-powered conductive heating elements (six per caisson), which were placed into protective outer heater casings constructed of thick-wall (approximately 0.5-inch) steel because of the highly corrosive environment. Thirty-six thermocouples were installed within each caisson to provide real-time temperature profiles, both laterally and vertically, throughout the acid tar material.

The vapor space in each caisson was inerted with a continuous flow of nitrogen to maintain low oxygen concentrations (i.e., less than 5 percent) to minimize the risk of fire and explosion. The vapor treatment train included a thermal oxidizer to destroy organic compounds and oxidize reduced sulfur compounds and a caustic scrubber to reduce concentrations of acid gasses. Figure 2 illustrates the complete layout of the ISTT system.

Pilot Study Operation

The thermal treatment system was constructed between October 2013 and February 2014. The ISTT process operated for 71 days commencing on February 28, 2014 and concluding on May 9, 2014. During thermal treatment, operations were manned 7 days a week, 24 hours a day. Impoundment material samples were collected and analyzed before and after treatment to determine physical and chemical characteristics and evaluate ISTT effectiveness. The pilot study was supported by a comprehensive monitoring program that included a wide range of sampling, analysis, and data collection tasks. The following sections provide an overview of pilot study equipment operation and performance.

Temperature Profiles

Temperatures were monitored by thermocouples located at 30 discrete points within each caisson and an additional six monitoring points located in the annular space between each of the caissons and its outer shroud. The thermocouples were located along five vertical “strings” within each caisson plus one string in the annular space; with six thermocouples placed at approximately 2-foot intervals along each string. To represent ambient conditions during the pilot study, one additional string of thermocouples was installed in an area isolated from heating operations. In total, temperature measurements were completed during the pilot study at 78 discrete locations within Caissons 2 and 3. Figure 1 illustrates the lateral distribution of temperature monitoring points used in the pilot study.

The operating temperatures of caisson heaters (12 total, 6 per caisson) also were monitored and recorded throughout the pilot study by thermocouples located within the heater assembly approximately every 3 feet of heater length.

The average treatment temperature achieved in Caissons 2 and 3 over the pilot study duration is illustrated on Figure 3. Caisson 2 reached a maximum average treatment temperature of 83 degrees Celsius (°C) on April 25, 2014; Caisson 3 reached a maximum average treatment temperature of 97°C on May 7, 2014. On or about April 23, 2014, the average temperature in Caisson 3 reached 90°C and was maintained at or above this temperature until pilot study shutdown on May 9, 2014.

As outlined in the *100 Percent Design of Pilot Study for Operable Unit 8* (CH2M HILL 2013a), a target treatment temperature of 100°C was established. Process operational challenges experienced during the pilot study prevented both caissons from reaching the target treatment temperature. During early stages of pilot study equipment operation, heaters routinely shut down because of condensate production within the vapor system oxygen sensors. In late March 2014, two heaters within Caisson 2 had corroded. Detailed inspection confirmed that one heater could no longer be operated safely. Power to the damaged heater was disconnected, and the assembly was physically isolated at the caisson cover to prevent air introduction. The second heater was successfully repaired and returned to operation. As a result, Caisson 2 operated with only five heaters for the final 39 days of the pilot study.

Although the average temperature of materials within Caisson 2 and 3 did not reach 100°C, temperatures within the “core” of Caisson 3 (excluding temperature readings at the top or bottom of the caisson) exceeded 100°C between April 27, 2014 and May 9, 2014, when heater operation was terminated. Despite average treatment temperatures that were lower than originally designed, contaminant mass flow measurements collected real-time and through fixed laboratory vapor samples confirmed a significant mass of VOC and reduced sulfur compounds were removed through heating. The effects of heat on contaminant mass removal measured in the pilot study were similar to observations of mass removal compiled during laboratory testing. In general, the results of laboratory testing indicated notable mass removal (based on

condensate generated in the laboratory) when operational temperatures reached 70°C. Observations of mass removal during the pilot study were similar, whereby a significant mass of VOCs was removed during heat up and as temperatures progressed beyond 70°C and approached the benzene boiling point of 80°C. Given the correlation between temperature and mass removal observed under laboratory and field conditions, cumulative mass removal, rather than temperature profiles, was adopted as the primary metric used in determining the shutdown point for thermal treatment operations during the pilot study.

Vapor Extraction and Treatment

To evaluate the effectiveness of vapor treatment using thermal oxidization, influent and effluent sample pairs were collected for laboratory analysis throughout the pilot study. Key parameters evaluated during system operations included benzene, total VOCs, and sulfur-bearing compounds. Paired samples were collected weekly from March 14, 2014 through April 25, 2014. A summary of paired influent and effluent sample results, comparing influent and effluent concentrations, is provided in Table 1. In addition, the calculated destruction and removal efficiency (DRE) for each sampling event is presented in Table 1.

Initial samples collected in March 2014 indicated the DRE for benzene and total VOC was greater than 99 percent. High variability was observed in benzene concentrations measured at the thermal oxidizer influent following the start of caisson heating operations. Benzene concentration values ranging between 1,100,000 and 3,800,000 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) (approximately 344,000 to 1,189,000 parts per billion by volume [ppbv]) were initially measured; however, by April 2014, variability and concentration decreased significantly in the influent samples. Observed benzene concentration consistently measured between 230,000 and 450,000 $\mu\text{g}/\text{m}^3$ (approximately 71,000 and 140,000 ppbv) in the influent vapor after April 2014. Despite decreasing benzene concentrations in the influent, a notable increase in benzene and total VOCs concentration was observed in the thermal oxidizer effluent samples. Accordingly, the DRE for benzene and total VOCs decreased and ranged between 90 and 95 percent during April 2014.

The thermal oxidizer initially was operated at temperatures between 850 and 900°C (approximately 1,550 to 1,650 degrees Fahrenheit [$^{\circ}\text{F}$]). To evaluate the effects of temperature on reduced DRE observed in April 2014, the operating temperature of the thermal oxidizer was increased to approximately 926°C (1,700°F) on April 25, 2014. Following the burner temperature increase, it was noted that exhaust temperatures had increased above the safety threshold established for packing used in the caustic scrubbing tower. Therefore, the burner temperature was reduced to 900°C (1,650°F) where it was maintained for the duration of the ISTT phase of the pilot study. After increasing operating temperature, DRE improvements were noted to greater than 99 percent for benzene and total VOCs for the remainder of the pilot study.

In addition to increasing burner temperature, the sample tap used to collect influent vapor to the thermal oxidizer also was replaced on April 29, 2014. Routine equipment inspection identified deficiencies in the sample port that were attributed to the effects of localized corrosion and vibration from blower operation. Following these changes, DRE for benzene and total VOCs increased to early term operational performance observations. Throughout the pilot study duration, DRE for sulfur-bearing compounds exceeded 99 percent.

With the exception of the inlet vapor sample tap, the thermal oxidizer piping, burner, and combustion chamber did not display obvious signs of corrosion during the pilot study. However, the flame arrestor installed downstream of the blowers required excessive maintenance and cleaning, which occurred daily during the latter part of the study because of accumulation of tar-like material between the flame baffles.

Mass Flow Estimates and Cumulative Mass Removal

The original contaminant mass estimate for the two caissons, based on results of laboratory analyses before the study, was approximately 6,300 pounds of total VOCs. During the ISTT portion of the pilot study, contaminant mass flow was calculated using two methods. The first method was based upon real-time VOC measurements collected at the influent of the thermal oxidizer, along with flow rates, to calculate mass flow. The second method was based upon the laboratory analytical results from vapor samples collected at the influent of the thermal oxidizer. Mass flow estimates developed for each of these methods were then

used to estimate cumulative mass removal. The results of each mass flow estimate approach and the cumulative mass removal based on each method are described in the following sections.

Real-Time Mass Flow Estimate

Real-time measurements of the combined inlet to the oxidizer (after dilution air was added) were performed using a Prevex flammability analyzer. The percent of lower flammability limit (%LFL) measured by this instrument was converted to British thermal units (BTU)/standard cubic feet (scf) using the LFL of the calibration gas (ethylene) and the flow as measured in the vapor conveyance piping. These measurements were used to track mass removal throughout the pilot study. Based on these real-time measurements, the cumulative mass of total VOCs removed from both caissons was estimated at 5,930 pounds. Figure 4 illustrates the total mass of VOCs removed as estimated using the Prevex flammability analyzer.

Laboratory Analytical Mass Flow Estimate

This method used the data generated from the process vapor samples collected at the thermal oxidizer inlet, which were analyzed in an offsite laboratory for VOCs (USEPA Method TO15) and reduced sulfur (ASTM Method D5504). The total VOC and reduced sulfur concentrations measured by laboratory analyses were used with the vapor flow rate to the thermal oxidizer to calculate the cumulative mass removed with time. The cumulative mass of total VOCs removed from both caissons based on laboratory data from influent vapor samples was estimated at 7,880 pounds. Of this total, approximately 5,150 pounds of the total VOCs removed is attributed to benzene. Figure 4 illustrates the total mass of VOCs removed as estimated using influent vapor laboratory analytical data.

Mass Flow over Time

Influent samples collected and analyzed in the laboratory show that the highest concentration of VOCs extracted from caissons occurred in the early stages of the project (during the first 2 weeks of heating). Influent vapor sampling results as a function of time based on laboratory analysis are summarized on Figure 5. Following the start of thermal treatment, the influent vapor phase benzene concentration exceeded 350,000,000 µg/m³ or approximately 110,000,000 ppbv. With increasing operation time and increasing temperature in the caissons, the influent vapor concentration of benzene decreased significantly, ranging between 50,000 and 100,000 µg/m³ (approximately 15,000 and 31,000 ppbv).

As previously described, mass removal rates for total VOCs were calculated by two methods. Using laboratory derived data the maximum removal rate of total VOCs observed was 403 pounds per day (lb/day). In comparison the average mass flow removal rate for total VOCs during the last 10 days of system operation was 49.6 ± 23.2 lb/day which was approximately 12 percent of the peak value. Measurements using the Prevex analyzer data suggested total VOC removal rates were slightly higher. This calculation method indicated the maximum total VOC removal rate was 567 lb/day; the average total VOC removal rate over the last 10 days was 52.5 ± 27.5 lb/day which measured approximately 9 percent of the peak rate.

Influent Vapor Composition

Laboratory analysis of influent vapor confirmed the presence of VOCs and SVOCs similar to those observed in the laboratory and from previous sampling events, and included benzene, xylenes, toluene, naphthalene, chlorobenzene, and carbon disulfide, which were detected in vapor extracted from the caissons at appreciable concentrations. Consistent with laboratory studies, hydrogen sulfide also was detected throughout the pilot study at a concentration ranging from approximately 25,000 to 50,000 µg/m³ (approximately 18,000 to 36,500 ppbv). Overall, extracted vapor was comprised of more than 30 percent benzene on a concentration basis as illustrated on Figure 6.

Thermal System Performance and Shutdown

Caissons 2 and 3 were estimated to contain approximately 6,300 pounds of total VOC prior to ISTT. Real-time monitoring estimated that more than 5,900 pounds of total VOCs had been removed through heating operations, while the laboratory data showed an estimated 7,800 pounds of VOCs had been

removed during treatment. Real-time monitoring primarily was used to determine shutdown of the system, which demonstrated a 95 percent reduction of total VOCs.

Mass flow estimates made using both data sources suggest contaminant extraction rates had stabilized by the end of March 2014. Despite day-to-day fluctuations in the measured mass flow rate over the last 30 days of system operation, there was no appreciable change in overall mass removal rate. Thermal treatment operations were terminated on May 9, 2014, based on following lines of evidence:

- The cumulative total VOC mass removed from real-time monitoring demonstrated 95 percent reduction in total VOC concentrations.
- Despite increasing temperatures in the caissons, the rate of contaminant removal in extracted vapor, as estimated using both laboratory and real-time monitoring methods, remained unchanged with increasing system operation time.
- The steady state average removal rate for total VOCs had decreased to approximately 10% of the peak total VOC removal rate observed during system operation.

Pilot Study Monitoring Results

The pilot study was supported by a comprehensive monitoring program which included a wide range of sampling, analysis, and data collection tasks. An overview of sampling and monitoring completed during the pilot study and the results is provided in the *Draft Field-Scale Demonstration Study Results Report for Operable Unit 8 Pilot Study Report* (CH2M HILL 2014b). This section provides an overall summary of the results as they relate to the ISTT phase of the pilot study.

Perimeter Air Monitoring

Perimeter air monitoring was conducted continuously throughout the pilot study, and no exceedances of the threshold vapor levels established in the *Perimeter Air Monitoring Plan* (CH2M HILL 2013g) were observed to be associated with ISTT pilot study operations. During pilot study operations, ambient air samples also were collected from three locations surrounding the study area; an additional sampling location was monitored within the process treatment area. Benzene was detected in ambient air at the perimeter stations during ISTT system operations at a concentration range from nondetect to a maximum of 7.8 µg/m³ (2.4 ppbv). The observed concentration values were consistent with background measurements collected since July 2012 which have historically ranged between nondetect and 12 µg/m³ (3.8 ppbv). With one exception where benzene was detected at 5.3 µg/m³ (1.7 ppbv) all remaining observations during ISTT system operation were below 3 µg/m³ (0.9 ppbv). Benzene concentrations in the work zone also were low throughout ISTT system operations with measured values significantly below the Occupational Safety and Health Administration (OSHA) time-weighted average concentration.

Groundwater Monitoring

Groundwater monitoring was performed to assess if pilot study implementation resulted in measurable change in groundwater quality in the vicinity of Impoundments 1 and 2. During the operation of the ISTT system, there were no appreciable increases in groundwater temperature at any piezometers and pH remained stable in upgradient and downgradient monitoring locations. It is believed that increased temperature and depressed pH would be the strongest indicators of impacts related to the pilot-scale study. Similarly, conductivity remained stable in all monitoring locations. Turbidity, dissolved oxygen, and oxidation reduction potential (ORP) showed the most variability during baseline monitoring and post startup monitoring. Observed changes however, quickly returned to baseline conditions and are attributable to precipitation events.

In all monitoring locations PID readings remained stable, most notably the piezometers closest to the ISTT zone. This observation is supported by post-ISTT groundwater analytical results which were consistent with and unchanged in comparison to baseline concentration measurements. In summary, the groundwater analytical and monitoring results indicate that there were no negative impacts to groundwater quality from

the OU8 Pilot Study activities proximate to Impoundment 2. Supplemental results of the groundwater monitoring program are presented in the *Draft Field-Scale Demonstration Study Results Report for Operable Unit 8 Pilot Study - American Cyanamid Superfund Site* (CH2M HILL. 2014b).

Water Cap Sampling

Throughout the pilot study, the water cap maintained over the impoundments was sampled in accordance with the USEPA-approved sampling and analysis plan (CH2M HILL 2013f) to determine if the pilot study produced a measurable change in water cap quality in either impoundment. Samples were collected weekly from four locations in Impoundment 2 (at the four corners of the impoundment) and two locations in Impoundment 1 during the study.

Figure 7 presents the results of average VOC concentration measured in water cap samples collected from Impoundments 1 and 2 before and during the ISTT portion of the pilot study. Baseline results were consistent with historical site observations whereby benzene was the predominate VOC detected in water cap samples. Benzene concentrations during baseline sampling (October and November 2013) ranged from 700 to 1,000 micrograms per liter ($\mu\text{g}/\text{L}$) in Impoundment 2; over the same period, benzene concentrations in Impoundment 1 measured between 297 and 398 $\mu\text{g}/\text{L}$.

Increases in VOC concentration above background values were measured during initial implementation of the ISTT pilot study. Specifically, the VOC concentrations in samples collected during two sampling events performed on March 25 and 28, 2014, were notably higher than baseline measurements. Among the VOCs detected, the average concentration trends observed in Impoundment 2 samples were similar as illustrated on Figure 7. Collected in late March 2014, the water samples represent nearly 1 month of ISTT operation; however, the March 2014 samples also mark the first measurements of water quality that could be obtained following the melting of ice from the impoundment surface. It remains unclear whether elevated values observed in March 2014 are related to pilot study operations or the prolonged presence of the ice cap observed during the cold winter months. In either case, benzene concentrations observed in April 2014 during continued ISTT operations decreased to levels that were consistent with baseline measurements.

Corrosion Study Results

Materials contained within the impoundments vary considerably in acid content. Because elevated temperatures can dramatically affect corrosion processes, a detailed evaluation of several construction materials was performed during the pilot study. To evaluate the effects of ISTT on construction materials, a series of metal coupons were placed into the impoundment materials at various locations to evaluate corrosion. The materials tested were:

- A36 Carbon Steel
- 316 L Stainless Steel
- AL-2205
- SAF-2507
- AL6XN
- HASTELLOY C276

During the pilot study, five general exposure conditions were tested, as outlined below:

- Acid Tar – Impoundment material at ambient temperature (Caisson 1)
- Acid Tar less than 150°C –Impoundment material at central multiphase extraction well (Caisson 2 and 3)
- Acid Tar greater than 150°C - Impoundment material along heater casing (Caisson 2 and 3)
- Liquid – Combined liquid stream extracted from Caisson 2 and 3
- Vapor – Individual vapor streams extracted from Caisson 2 and 3

In general, carbon steel was considered the baseline material to which performance of all other materials was compared. Corrosion study results are summarized on Figure 8. Materials tested are grouped by exposure condition, and the average corrosion rate in mills per year (shown on log scale) is presented on the horizontal axis. As anticipated, corrosion-resistant alloys, such as AL6XN and C276, saw limited attack under the conditions evaluated. Carbon steel exhibited the highest corrosion rate of any material tested under the exposure scenarios. Stainless steel (316L) performed well under each exposure condition, especially in

contact with heated impoundment materials. Performance of 316L in these environments was similar to, and in several cases better than, the duplex stainless steel alloys (2205 and 2507) tested. In summary, the study results illustrate a range of potential construction materials is compatible with impoundment material under process conditions evaluated during the ISTT pilot study.

After the ISTT pilot study was completed, the thermal treatment unit was dismantled, and the equipment that contacted either impoundment materials or extracted vapors was visually inspected for corrosion. As presented earlier, significant corrosion occurred in heater cans from Caisson 2. One heater can was perforated in multiple locations, and roughly 3 linear feet of a second heater can had eroded. Although the perforated heater can remained operational for the pilot study, the second heater can was inoperable and was permanently shut down. Temperature cycling early in pilot study operations also is believed to have initiated premature failure of two heaters in Caisson 2. Based on component inspections following pilot study completion, thermal cycling, reflux of acidic solids, and condensation of acid vapors are likely attributed to observed heater corrosion. Observed differences in corrosion characteristics between two caissons that were placed 15 feet apart in the impoundment suggests spatial variability in impoundment materials may be a factor.

The vapor lines from the caissons to the thermal oxidizer did not exhibit significant corrosion. This observation is attributed to operation of insertion heaters and pipe insulation, which minimized the potential for condensate to generate in the lines. Following completion of ISTT operations, detailed equipment inspection and implementation of routine maintenance procedures for the thermal oxidizer burner and combustion chamber did not identify obvious or visual signs of aggressive material corrosion.

Technology Performance

Material samples were collected at various stages throughout the pilot study, including before and after thermal treatment, after removing the material from the caisson, and after additional ex-situ stabilization. Selected samples were analyzed for one or more following parameters: VOCs (standard, toxicity characteristic leaching procedure [TCLP], and synthetic precipitation leaching procedure [SPLP]), SVOCs (standard, TCLP, and SPLP), metals (standard, TCLP, and SPLP), and/or various physical characteristics (pH, moisture content, bulk density, dry density, unconfined compressive strength (UCS), hydraulic conductivity, and loss on ignition). Sampling and analysis was conducted in accordance with the USEPA-approved sampling and analysis plan (CH2M HILL 2013h) and May 2014 sampling and analysis plan addendum (CH2M HILL 2014a). The following samples were collected from each caisson:

- Caisson 2 (ISTT Only): Two raw tar samples were collected in November 2013. Nine samples from within the caisson were collected following completion of ISTT operations in May 2014. Two additional samples were collected following material removal, and one final sample was collected from the storage bin after a second state of stabilization (ex-situ) was completed in June 2014.
- Caisson 3 (ISTT/ISS): Two raw tar samples were collected in November 2013. Nine post-ISTT samples and two post-ISS samples (in caisson) were collected in May 2014. Two post-removal samples (from rolloff container) and two post-secondary stabilization samples (from rolloff container) were collected in June 2014.

Analytical Results

Analytical results for Caissons 2 and 3 are presented in Tables 2 and 3, respectively; Figure 9 depicts the pre- and post-treatment sample locations obtained from Caissons 2 and 3. Table 4 provides an overall summary of Caissons 2 and 3 data, including the average concentration and standard deviation observed for benzene, total VOCs, and naphthalene (which is not included in the total VOC value). These parameters were selected for discussion because they represent the most significant constituents in the acid tar.

Bar graphs representing measured changes in the average concentration of benzene, total VOCs, and naphthalene for Caissons 2 and 3 are presented on Figures 10 and 11, respectively. Pre-treatment conditions measured in Caissons 2 and 3 are summarized below:

Constituent	Caisson 2	Caisson 3
Average Benzene (mg/kg)	96,100	66,950
Average Total VOCs (mg/kg)	129,432	88,078
Average Naphthalene (mg/kg)	22,000	9,960

mg/kg = milligrams per kilogram

Nine post-ISTT samples were collected from Caisson 2 and 3 at various depth intervals and at a range of lateral distances from the heater locations. Unlike the laboratory studies, materials in both caissons retained low pH values (approximately 2 SU) at the completion of thermal treatment operations. Post-treatment results were similar between Caisson 2 and 3 following completion of thermal operations and showed significant concentration decreases. Treatment performance of ISTT operations in each caisson is summarized as follows:

- In Caisson 2, post-treatment samples showed reduction from initial concentrations. At heating completion in the nine post-ISTT samples, benzene ranged from 3,160 to 11,000 milligrams per kilogram (mg/kg), total VOCs ranged from 6,005 to 15,660 mg/kg, and naphthalene ranged from 1,550 to 8,290 mg/kg.
- In Caisson 3, eight of the nine samples showed a significant decrease in concentrations. Measured concentration in eight post-ISTT samples for benzene ranged from 19 to 308 mg/kg, total VOCs ranged from 34 to 1,096 mg/kg, and naphthalene ranged from 273 to 2,530 mg/kg. These results exclude a single outlier sample (see explanation below).

Post-treatment reductions observed in Caisson 3 were heavily skewed by one sample (052814-TAR-TC03B-076080), which was collected at the base of the thermal treatment zone near the clay layer where heat delivery was most difficult, in order to protect the clay layer. Because heaters did not extend beyond the clay liner (beyond the caisson bottom), there was limited effectiveness in heating the interface between impoundment material and the clay liner. This was a known limitation of the pilot study design, and the absence of treatment at depth was seen in the post-treatment sampling results with a benzene concentration of 61,900 mg/kg and total VOC concentration of 76,502 mg/kg, which were similar to the pre-treatment analytical measurements. For this reason, data from the outlying sample were excluded from the range and median analyses in Table 4; however, to facilitate comparison of pre- and post-ISS results, the results from this sample were included in the average calculation for post-ISTT results.

TCLP and SPLP

Benzene TCLP and SPLP results are summarized in Table 4, and comprehensive TCLP and SPLP results are presented in Tables 5 and 6, respectively. Benzene TCLP and SPLP results are presented graphically on Figure 12 (Caisson 2) and Figure 13 (Caisson 3). Impoundment material in both caissons produced elevated pre-treatment benzene TCLP and SPLP results, with concentrations ranging from 399 to 531 milligrams per liter (mg/L). As observed with the previously discussed data, the largest reductions in benzene TCLP and SPLP concentrations were associated with thermal treatment of Caisson 3. Results of TCLP and SPLP analysis are summarized as follows:

- In Caisson 2, each of the TCLP results for benzene exceeded the 0.5 mg/L “hazardous characteristic” criterion. Benzene concentration in TCLP and SPLP extract averaged 106 and 68 mg/L, respectively; overall, benzene concentrations in samples analyzed ranged from 29 to 198 mg/L.

- In Caisson 3, four of the six samples had TCLP concentrations below the 0.5 mg/L “hazardous characteristic” criterion, with concentrations ranging from less than 0.08 to 0.45 mg/L (three orders of magnitude reduction in concentrations). Two of the samples had benzene TCLP concentrations of approximately 3 and 12 mg/L, with the later result being observed near the bottom of the caisson.

Physical Analytical Results

Following thermal treatment, materials from Caissons 2 and 3 were collected and analyzed for various physical parameters as presented in Table 7. The untreated acid tar had a UCS of 0 pounds per square inch (psi). Samples of thermally treated materials collected from Caissons 2 and 3 showed a notable improvement in strength. The average 28 day UCS measurements reported in Caisson 2 was 86 psi. In Caisson 3, the average UCS was 33 psi after 28 days. Between all thermally treated locations analyzed, UCS measurements ranged between 9 and 148 psi (Table 7).

References

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Tables

TABLE 1
Comparison of Influent and Effluent Concentrations of Benzene, Total VOCs, and Total Reduced Sulfur
OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Sample Date	Inlet			Outlet			Destruction and Removal Efficiency (DRE)				
	Oxidizer Flow, SCFM	Benzene ($\mu\text{g}/\text{m}^3$)	Total VOCs ($\mu\text{g}/\text{m}^3$)	Total Reduced Sulfur ($\mu\text{g}/\text{m}^3$)	Outlet Flow, SCFM	Benzene ($\mu\text{g}/\text{m}^3$)	Total VOCs ($\mu\text{g}/\text{m}^3$)	Total Reduced Sulfur ($\mu\text{g}/\text{m}^3$)	Benzene (Percent)	Total VOCs (Percent)	Total Reduced Sulfur (Percent)
3/14/2014	713	3,800,000	4,658,300	451,360	856	6,800	8,218	139	99.79	99.79	99.96
3/19/2014	681	1,000,000	1,224,200	51,330	842	7,000	7,651	76	99.13	99.23	99.82
3/26/2014	1,017	400,000	612,930	377,520	1,103	17,000	22,892	1,121	95.39	95.95	99.68
4/2/2014	894	340,000	441,850		1,006	21,000	25,338		93.05	93.55	
4/9/2014	734	230,000	356,810	247,160	1,001	24,000	29,530	1,144	85.77	88.72	99.37
4/11/2014	728	790,000	1,310,500	285,690	1,001	33,000	40,656	1,790	94.26	95.74	99.14
4/14/2014	779	450,000	824,300	93,910	1,059	14,000	18,018	993	95.77	97.03	98.56
4/25/2014	647	260,000	412,580	105,090	1,074	3,100	78	16	98.02	99.97	99.97
4/25/2014	647	390,000	583,800	228,180	1,074	2,700	3,135	48	98.85	99.11	99.97
4/29/2014	640	330,000	467,720	312,850	1,074	11	98	29	99.99	99.96	99.98
5/2/2014	634	300,000	475,670	18,640	1,074	20	140	31	99.99	99.95	99.72
5/7/2014	583	380,000	724,300	431,980	1,074	27	137	130	99.99	99.97	99.94

Notes:

1. SCFM – standard cubic feet per minute

2. $\mu\text{g}/\text{m}^3$ – microgram per cubic meter

3. VOCs – volatile organic compounds

Table 2

Caisson 2 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		Caisson #2		2/28/14-5/19/14	CAISSON #2									6/4/2014	ROLL OFF				
Sample Date		11/12/2013			5/19/2014	5/27/2014										6/4/2014			
Treatment Stage		Pre Thermal (Raw Tar)			Post Thermal								Post Removal			Post Removal			
Core/Depth		0-1.2'			A - 0-2'	A - 5-7'	A - 7-8.7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	C - 5-7'	C - 9-10'		Sample A				
Parameter	Unit	112113-TAR-TC02-0012 (Encore)	112113-TAR-TC02-0012 (Terracore)		051914-TAR- TC02-000001	052714-HC- TC02A-000020	052714-HC- TC02A-050070	052714-HC- TC02A-070087	052714-TAR- TC02B-000027	052714-HC- TC02B027050	052714-HC- TC02B-08100	052714-TAR- TC02C-010032	052714-HC- TC02C-050070	052714-HC- TC02C-090100	060414-TAR- TC02A	060414-TAR- TC02B			
VOCs															R				
1,1,1-TRICHLOROETHANE	ug/kg	< 10500	< 9190		< 6200	< 3000	< 26000	< 2100	< 2900	< 2100	< 2300	< 14000	< 2800	< 4300	E	< 2700	< 290		
1,1,2,2-TETRACHLOROETHANE	ug/kg	--	< 9900		< 7400	< 3600	< 31000	< 2500	< 3500	< 2500	< 2700	< 17000	< 3300	< 5200	M	< 3300	< 350		
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	ug/kg	< 24100	< 21100		< 9400	< 4500	< 39000	< 3200	< 4400	< 3200	< 3400	< 22000	< 4300	< 6600	O	< 4100	< 440		
1,1,2-TRICHLOROETHANE	ug/kg	< 4160	< 3630		< 18000	< 8600	< 73000	< 6000	< 8400	< 6000	< 6500	< 41000	< 8000	< 12000	V	< 7800	< 830		
1,1-DICHLOROETHANE	ug/kg	< 6250	< 5470		< 6800	< 3300	< 28000	< 2300	< 3200	< 2300	< 2500	< 16000	< 3100	< 4700	A	< 3000	< 320		
1,1-DICHLOROETHENE	ug/kg	< 14700	< 12900		< 6200	< 3000	< 26000	< 2100	< 2900	< 2100	< 2300	< 14000	< 2800	< 4300	L	< 2700	< 290		
1,2,3-TRICHLOROBENZENE	ug/kg	< 23400	< 20400		< 4500	< 2200	< 19000	< 1500	< 2100	< 1500	< 1600	< 10000	< 2000	< 3100	< 2000	< 210			
1,2,4-TRICHLOROBENZENE	ug/kg	< 19800	< 17300		< 3900	< 1900	< 16000	< 1300	< 1800	< 1300	< 1400	< 9000	< 1800	< 2700		< 1700	1030 J		
1,2-DIBROMO-3-CHLOROPROPANE	ug/kg	< 18500	< 16200		< 29000	< 14000	< 120000	< 9700	< 14000	< 9700	< 10000	< 66000	< 13000	< 20000		< 13000	< 1300		
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ug/kg	< 13300	< 11700		< 12000	< 5700	< 49000	< 4000	< 5600	< 4000	< 4300	< 27000	< 5400	< 8300		< 5200	< 560		
1,2-DICHLOROBENZENE	ug/kg	5,090,000	2,840,000		601,000	506,000	472,000	464,000	452,000	445,000	473,000	716,000	319,000	416,000		552,000	462,000		
1,2-DICHLOROETHANE	ug/kg	< 12800	< 11200		< 7000	< 3400	< 29000	< 2300	< 3300	< 2300	< 2500	< 16000	< 3100	< 4900		< 3100	< 330		
1,2-DICHLOROPROPANE	ug/kg	< 4940	< 4320		< 9400	< 4600	< 39000	< 3200	< 4400	< 3200	< 3400	< 22000	< 4300	< 6600		< 4200	< 440		
1,3-DICHLOROBENZENE	ug/kg	76700 J	44900 J		8530 J	6160 J	< 20000	5490 J	5980 J	5150 J	7000 J	< 11000	4180 J	4850 J		8090 J	7,560		
1,4-DICHLOROBENZENE	ug/kg	407,000	271000 J		48300 J	37800 J	40900 J	34400 J	32900 J	33800 J	38900 J	58800 J	24100 J	33300 J		47000 J	43,600		
1,4-DIOXANE (P-DIOXANE)	ug/kg	--	--		< 1700000	< 800000	< 6800000	< 560000	< 780000	< 560000	< 600000	< 3800000	< 750000	< 1200000		< 730000	< 78000		
2-HEXANONE	ug/kg	< 19200	< 16800		< 39000	< 19000	< 160000	< 13000	< 18000	< 13000	< 14000	< 89000	< 17000	< 27000		< 17000	< 1800		
ACETONE	ug/kg	66500 J	71000 J		< 99000	< 48000	< 410000 J	< 33000	< 46000	< 33000	< 36000 J	< 230000 J	< 45000	< 69000		< 43000	11,800		
BENZENE	ug/kg	96,400,000	95,800,000		4,150,000	4,750,000	11,000,000	3,460,000	3,610,000	3,160,000	10,000,000	7,560,000	3,260,000	6,800,000		4,100,000	8,140,000		
BROMOCHLOROMETHANE	ug/kg	< 21500	< 18800		< 11000	< 5400	< 46000	< 3800	< 5300	< 3800	< 4100	< 26000	< 5100	< 7800		< 4900	< 530		
BROMODICHLOROMETHANE	ug/kg	< 6720	< 5870		< 6100	< 2900	< 25000	< 2100	< 2900	< 2000	< 2200	< 14000	< 2700	< 4200		< 2700	< 290		
BROMOFORM	ug/kg	< 28300	< 24800		< 5700	< 2700	< 23000	< 1900	< 2700	< 1900	< 2100	< 13000	< 2600	< 4000		< 2500	< 270		
BROMOMETHANE	ug/kg	< 31500	< 27500		< 10000	< 5000	< 43000	< 3500	< 4900	< 3500	< 3800	< 24000	< 4700	< 7300		< 4600	< 490		
CARBON DISULFIDE	ug/kg	135000 J	123000 J		< 3100	< 1500	< 13000	2330 J	< 1400	< 1000	4370 J	< 7000	< 1400	< 2100		2130 J	4320 J		
CARBON TETRACHLORIDE	ug/kg	< 12200	< 10700		< 5400	< 2600	< 22000	< 1800	< 2600	< 1800	< 2000	< 12000	< 2500	< 3800		< 2400	< 250		
CHLOROBENZENE	ug/kg	44500 J	26700 J		< 4300	< 2100	< 18000	1880 J	< 2000	1840 J	< 1500	< 9800	< 1900	< 3000		< 1900	2780 J		
CHLOROETHANE	ug/kg	< 13100	< 11400		< 22000	< 10000	< 89000	< 7300	< 10000	< 7300	< 7800	< 50000	< 9700	< 15000		< 9500	< 1000		
CHLOROFORM	ug/kg	< 11200	< 9780		< 5500	< 2700	< 23000	< 1900	< 2600	< 1900	< 2000	< 13000	< 2500	< 3800		< 2400			

Table 2

Caisson 2 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		Caisson #2		2/28/14-5/19/14	CAISSON #2									6/4/2014	ROLL OFF				
Sample Date		11/12/2013			5/19/2014	5/27/2014										6/4/2014			
Treatment Stage		Pre Thermal (Raw Tar)			Post Thermal										Post Removal				
Core/Depth		0-1.2'	0-1.2'		Vibracore Attempt	A - 0-2'	A - 5-7'	A - 7-8.7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	C - 5-7'	C - 9-10'	Sample A	Sample B			
Parameter	Unit	112113-TAR-TC02-0012 (Encore)	112113-TAR-TC02-0012 (Terracore)		051914-TAR-TC02-000001	052714-HC-TC02A-000020	052714-HC-TC02A-050070	052714-HC-TC02A-070087	052714-TAR-TC02B-000027	052714-HC-TC02B027050	052714-HC-TC02B-08100	052714-TAR-TC02C-010032	052714-HC-TC02C-050070	052714-HC-TC02C-090100	060414-TAR-TC02A	060414-TAR-TC02B			
TETRACHLOROETHYLENE (PCE)	ug/kg	< 19200	< 16800		< 8900	< 4300	< 37000	< 3000	< 4200	< 3000	< 3200	< 20000	< 4000	< 6200	< 3900	< 420			
TOLUENE	ug/kg	23,900,000	20,500,000		2,130,000	1,750,000	2,600,000	1,300,000	1,190,000	1,310,000	3,140,000	2,820,000	1,230,000	1,850,000	1,250,000	2,390,000			
TRANS-1,2-DICHLOROETHENE	ug/kg	< 7730	< 6750		< 9200	< 4400	< 38000	< 3100	< 4300	< 3100	< 3300	< 21000	< 4100	< 6400	< 4000	< 430			
TRANS-1,3-DICHLOROPROPENE	ug/kg	< 5330	< 4660		< 5800	< 2800	< 24000	< 2000	< 2700	< 2000	< 2100	< 13000	< 2600	< 4100	< 2600	< 270			
TRICHLOROETHYLENE (TCE)	ug/kg	< 8240	< 7210		< 7600	< 3700	< 31000	< 2600	< 3600	< 2600	< 2800	< 17000	< 3400	< 5300	< 3300	< 360			
TRICHLOROFLUOROMETHANE	ug/kg	< 8380	< 7330		< 4900	< 2300 J	< 20000	< 1600 J	< 2300 J	< 1600 J	< 1800	< 11000	< 2200 J	< 3400 J	< 2100	< 230			
VINYL CHLORIDE	ug/kg	--	< 11000		< 7400	< 3600	< 31000	< 2500	< 3500	< 2500	< 2700	< 17000	< 3300	< 5200	< 3300	< 350			
Total VOC (Sum of all VOCs)	ug/kg	133,643,600	125,219,900		7,938,230	8,254,810	15,659,700	6,362,060	6,676,680	6,357,770	14,610,140	12,893,700	6,004,580	10,763,680	6,833,720	12,113,355			
SVOCs																			
1,2,4,5-TETRACHLOROBENZENE	ug/kg	--	< 46300		< 160	< 310	< 290	< 490	< 300	< 280	< 140	< 300	< 320	< 260	< 290	< 150			
2,2-OXYBIS(2-CHLOROPROPANE)	ug/kg	--	--		< 150	< 300	< 290	< 480	< 290	< 270	< 130	< 290	< 310	< 260	< 280	< 150			
2,3,4,6-TETRACHLOROPHENOL	ug/kg	--	< 58500		< 530	< 1000	< 990	< 1600	< 1000	< 930	< 460	< 990	< 1100	< 890	< 970	< 510			
2,4,5-TRICHLOROPHENOL	ug/kg	--	< 59100		< 600	< 1200	< 1100	< 1900	< 1100	< 1000	< 520	< 1100	< 1200	< 1000	< 1100	< 570			
2,4,6-TRICHLOROPHENOL	ug/kg	--	< 65900		< 480	< 940	< 900	< 1500	< 930	< 850	< 420	< 910	< 970	< 810	< 880	< 460			
2,4-DICHLOROPHENOL	ug/kg	--	< 53900		< 830 J	< 1600	< 1500	< 2600	< 1600	< 1500	< 720	< 1600	< 1700	< 1400	< 1500	< 790			
2,4-DIMETHYLPHENOL	ug/kg	--	< 37000		28100 J	12,500	21,200	15600 J	17,400	23,500	15,800	21,700	7,150	35,200	32900 J	15,300			
2,4-DINITROPHENOL	ug/kg	--	< 128000		< 630	< 1200	< 1200	< 2000	< 1200	< 1100	< 540	< 1200	< 1300	< 1000	< 1100	< 600			
2,4-DINITROTOLUENE	ug/kg	--	< 38200		< 230	< 440	< 420	< 700	< 430	< 390	< 190	< 420	< 450	< 380	< 410	< 220			
2,6-DINITROTOLUENE	ug/kg	--	< 69900		< 200	< 380	< 370	< 610	< 380	< 340	< 170	< 370	< 390	< 330	< 360	< 190			
2-CHLORONAPHTHALENE	ug/kg	--	< 59700		< 160	< 310	< 300	< 500	< 310	< 280	< 140	< 300	< 320	< 270	< 290	< 150			
2-CHLOROPHENOL	ug/kg	--	< 41100		< 520	< 1000	< 960	< 1600	< 990	< 900	< 440	< 960	< 1000	< 860	< 940	< 490			
2-METHYLNAPHTHALENE	ug/kg	--	1260000 J		261,000	198,000	89,000	231,000	283,000	228,000	88,900	406,000	88,900	196,000	277,000	116,000			
2-METHYLPHENOL (O-CRESOL)	ug/kg	--	< 58000		< 590	1680 J	< 1100	< 1800	2,250	< 1000	2,090	< 1100	< 1200	1,780	< 1100	< 560			
2-NITROANILINE	ug/kg	--	< 23800		< 230	< 440	< 420	< 700	< 440	< 400	< 200	< 420	< 450	< 380	< 410	< 220			
2-NITROPHENOL	ug/kg	--	< 67000		< 550 J	< 1100	< 1000	< 1700	< 1000	< 960	< 470	< 1000	< 1100	< 910	< 990	< 520			
3- AND 4- METHYLPHENOL (TOTAL)	ug/kg	--	--		< 650	15,800	15,400	20200 J	22,100	18,000	13,700	12,500	6,550	17,200	30500 J	14,100			
3,3'-DICHLOROBENZIDINE	ug/kg	--	< 180000		< 130	< 250 J	< 240	< 410 J	< 250 J	< 230	< 110	< 250	< 260	< 220	< 240	< 130			
3-NITROANILINE	ug/kg	--	< 25500		< 210	< 400	< 380	< 640	< 400	< 360	< 180	< 390	< 410	< 340	< 370	< 200			
4,6-DINITRO-2-METHYLPHENOL	ug/kg	--	< 101000		< 630	< 1200	< 1200	< 2000	< 1200	< 1100	< 540	< 1200	< 1300	< 1000	< 1100	< 600			
4-BROMOPHENYL PHENYL ETHER	ug/kg	--	< 59700		< 190	< 360	< 350	< 580	< 360	< 330	< 160	< 350	< 370	< 310	< 34				

Table 2

Caisson 2 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		Caisson #2		2/28/14-5/19/14	CAISSON #2									6/4/2014	ROLL OFF				
Sample Date		11/12/2013			5/19/2014	5/27/2014										6/4/2014			
Treatment Stage		Pre Thermal (Raw Tar)			Post Thermal										Post Removal				
Core/Depth		0-1.2'	0-1.2'		Vibracore Attempt	A - 0-2'	A - 5-7'	A - 7-8.7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	C - 5-7'	C - 9-10'	Sample A	Sample B			
Parameter	Unit	112113-TAR-TC02-0012 (Encore)	112113-TAR-TC02-0012 (Terracore)		051914-TAR-TC02-000001	052714-HC-TC02A-000020	052714-HC-TC02A-050070	052714-HC-TC02A-070087	052714-TAR-TC02B-000027	052714-HC-TC02B-027050	052714-HC-TC02B-08100	052714-TAR-TC02C-010032	052714-HC-TC02C-050070	052714-HC-TC02C-090100	060414-TAR-TC02A	060414-TAR-TC02B			
BIPHENYL (DIPHENYL)	ug/kg	--	< 27700		22,200	24,200	22,800	18,800	22,900	19,900	11,200	20,400	10,900	18,400	45,600	18,500			
BIS(2-CHLOROETHOXY) METHANE	ug/kg	--	< 32700		< 210	< 400	< 390	< 650	< 400	< 360	< 180	< 390	< 420	< 350	< 380	< 200			
BIS(2-CHLOROETHYL) ETHER (2-CHLOROETHYL ETHER)	ug/kg	--	< 72700		< 160 J	< 300	< 290	< 480	< 300	< 270	< 130	< 290	< 310	< 260	< 280	< 150			
BIS (2-CHLOROISOPROPYL)ETHER	ug/kg	--	< 41100		--	--	--	--	--	--	--	--	--	--	--	--			
BIS(2-ETHYLHEXYL) PHTHALATE	ug/kg	--	< 26600		< 450	< 880	< 850	< 1400	< 870	< 800	< 390	< 850	< 910	< 760	< 830	< 440			
CAPROLACTAM	ug/kg	--	< 83000		< 160 J	< 310	< 300	< 500	< 310	< 280	< 140	< 300	< 320	< 270	< 300	< 160			
CARBAZOLE	ug/kg	--	< 36300		< 240	< 460	< 440	< 740	< 460	< 420	< 210	< 450	< 480	< 400	< 430	< 230			
CHRYSENE	ug/kg	--	< 40600		< 170	1,060	782 J	1040 J	< 330	< 300	< 150	< 330	< 350	< 290	< 320	< 170			
DIBENZ(A,H)ANTHRACENE	ug/kg	--	< 26900		< 180 J	< 340	< 330	< 550 J	< 340 J	< 310	< 150	< 330	< 350	< 290	< 320	< 170 J			
DIBENZOFURAN	ug/kg	--	< 35700		17,900	7,890	15,700	9,720	9,300	30,400	14,100	25,400	6,420	27,000	42,700	17,600			
DIETHYL PHTHALATE	ug/kg	--	< 69300		< 180	< 340	< 330	< 550	< 340	< 310	< 150	< 330	< 350	< 290	< 320	< 170			
DIMETHYL PHTHALATE	ug/kg	--	< 29200		< 180	< 350	< 340	< 560	< 350	< 320	< 160	< 340	< 360	< 300	< 330	< 170			
DI-N-BUTYL PHTHALATE	ug/kg	--	< 36300		< 110	< 220	< 210	< 360	< 220	< 200	< 99	< 210	< 230	< 190	< 210	< 110			
DI-N-OCTYLPHthalate	ug/kg	--	< 24800		< 250 J	< 490	< 470	< 780 J	< 480 J	< 440	< 220	< 470	< 500	< 420	< 460	< 240			
FLUORANTHENE	ug/kg	--	< 30500		9,050	3,100	2,850	3,090	4,280	3,170	1,230	2,410	1,280	3,250	4,010	1,890			
FLUORENE	ug/kg	--	5,720,000		< 170	< 330	< 310	< 530	< 320	< 300	< 150	< 320	< 340	< 280	< 310	< 160			
HEXACHLOROBENZENE	ug/kg	--	< 72700		< 170	< 330	< 310	< 520	< 320	< 290	< 140	< 310	< 340	< 280	< 310	< 160			
HEXACHLOROBUTADIENE	ug/kg	--	< 49700		< 140 J	< 280	< 270	< 450	< 270	< 250	< 120	< 270	< 290	< 240	< 260	< 140			
HEXACHLOROCYCLOPENTADIENE	ug/kg	--	< 398000		< 530	< 1000	< 980	< 1600	< 1000	< 920	< 450	< 980	< 1100	< 880	< 960	< 500			
HEXACHLOROETHANE	ug/kg	--	< 89200		< 140	< 280	< 270	< 450	< 270	< 250	< 120	< 270	< 290	< 240	< 260	< 140			
INDENO(1,2,3-C,D)PYRENE	ug/kg	--	< 45200		< 180 J	< 350	< 330	< 560 J	< 340 J	< 310	< 150	< 330	< 360	< 300	< 330	< 170 J			
ISOPHORONE	ug/kg	--	< 33400		< 140 J	< 270	< 260	< 430	< 270	39,900	12,100	< 260	< 280	64,300	< 250	< 130			
M,P-Cresol	ug/kg	--	< 70500		--	--	--	--	--	--	--	--	--	--	--	--			
NAPHTHALENE	ug/kg	--	22,000,000		5,780,000	3,180,000	3,540,000	1,900,000	5,170,000	3,740,000	1,560,000	8,290,000	1,550,000	3,460,000	5,840,000	2,330,000			
NITROBENZENE	ug/kg	--	< 97700		< 150 J	< 290	< 280	< 460	< 290	< 260	< 130	< 280	< 300	< 250	< 270	< 140			
N-NITROSODI-N-PROPYLAMINE	ug/kg	--	< 81800		< 130	< 240	< 230	< 390	< 240	< 220	< 110	< 240	< 250	< 210	< 230	< 120			
N-NITROSODIPHENYLAMINE	ug/kg	--	< 39700		< 310	< 600	< 570	< 960	< 590	< 540	< 270	< 580	< 620	< 510	< 560	< 290			
PENTACHLOROPHENOL	ug/kg	--	< 42000		< 880	< 1700	< 1600	< 2700	< 1700	< 1500	< 760	< 1600	< 1800	< 1500	< 1600	< 840			
PHENANTHRENE	ug/kg	--	< 43100		47,200	30,900	21,500	21,600	38,800	23,200	9,300	18,900	9,700	23,100	46,400	22,100			
PHENOL	ug/kg	--	< 51700		< 540	< 1000	< 1000	< 1700	< 1000	< 950	5,100	< 1000	< 1100	< 900	< 980	< 520			
PYRENE	ug/kg	--	< 26300		3,270	< 380	877 J	2,240	2,700	991	436 J	665 J	481 J	985	3,430	1,600			
PCBs																			
PCB, TOTAL	ug/kg	--	--																

Table 2

Caisson 2 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		Caisson #2		2/28/14-5/19/14	CAISSON #2									6/4/2014	ROLL OFF				
Sample Date		11/12/2013			5/19/2014	5/27/2014										6/4/2014			
Treatment Stage		Pre Thermal (Raw Tar)			Post Thermal											Post Removal			
Core/Depth		0-1.2'	0-1.2'		Vibracore Attempt	A - 0-2'	A - 5-7'	A - 7-8.7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	C - 5-7'	C - 9-10'	Sample A	Sample B			
Parameter	Unit	112113-TAR-TC02-0012 (Encore)	112113-TAR-TC02-0012 (Terracore)		051914-TAR-TC02-000001	052714-HC-TC02A-000020	052714-HC-TC02A-050070	052714-HC-TC02A-070087	052714-TAR-TC02B-000027	052714-HC-TC02B-027050	052714-HC-TC02B-08100	052714-TAR-TC02C-010032	052714-HC-TC02C-050070	052714-HC-TC02C-090100	060414-TAR-TC02A	060414-TAR-TC02B			
CADMUM	mg/kg	--	< 0.094		< 0.0097	1	0.012 J	< 0.008	< 0.0097	< 0.0085	< 0.0086	< 0.0095	< 0.01	< 0.0081	< 0.0093	< 0.0092			
CALCIUM	mg/kg	--	312		--	--	--	--	--	--	--	--	--	--	--	220 J			
CHROMIUM, TOTAL	mg/kg	--	4		--	--	--	--	--	--	--	--	--	--	--	57			
COBALT	mg/kg	--	0.25 J		--	--	--	--	--	--	--	--	--	--	--	2.2 J			
COPPER	mg/kg	--	27		4	60	13	1	2	0.25 J	0.12 J	1	1	0.32 J	4	2			
IRON	mg/kg	--	2,010		--	--	--	--	--	--	--	--	--	--	--	18,500			
LEAD	mg/kg	--	104		12	46	21	10	26	27	16.9 J	13	30	36	27	17			
MAGNESIUM	mg/kg	--	67		--	--	--	--	--	--	--	--	--	--	--	60.7 J			
MANGANESE	mg/kg	--	23		--	--	--	--	--	--	--	--	--	--	--	154			
MERCURY	mg/kg	--	2		< 0.0031	0	0	0	< 0.0031	0.0063 J	0	0.0053 J	< 0.0032	0	< 0.003 J	0			
NICKEL	mg/kg	--	5		5	97	18	5	5	7	7	3	6	4	13	7			
POTASSIUM	mg/kg	--	36 J		--	--	--	--	--	--	--	--	--	--	--	217 J			
SELENIUM	mg/kg	--	8		--	--	--	--	--	--	--	--	--	--	--	12			
SILVER	mg/kg	--	0.26 J		--	--	--	--	--	--	--	--	--	--	--	1			
SODIUM	mg/kg	--	2,360		--	--	--	--	--	--	--	--	--	--	--	3,280			
THALLIUM	mg/kg	--	< 0.38		--	--	--	--	--	--	--	--	--	--	--	< 4.2			
VANADIUM	mg/kg	--	1.28 J		--	--	--	--	--	--	--	--	--	--	--	4.2 J			
ZINC	mg/kg	--	50		6	11	8	6	51	8	9	4	8	7	5	3			
AVS/SEM																			
ACID VOLATILE SULFIDE	umol/g	--	--		< 0.08	< 0.08	< 0.08	< 0.06	< 0.08	< 0.07	< 0.07 J	< 0.08	< 0.08	< 0.07	< 0.07 J	< 0.07			
CADMUM	umol/g	--	--		< 0.0013	0	0.000107 J	< 0.0012	< 0.0013	< 0.0012	< 0.0012	< 0.0013	< 0.0014	< 0.0012	< 0.0013	< 0.0013			
COPPER	umol/g	--	--		0	1	0	0	0	0.00393 J	0.00189 J	0	0	0.00504 J	0	0			
LEAD	umol/g	--	--		0	0	0	0	0	0	0	0	0	0	0.131 J	0			
MERCURY	umol/g	--	--		< 0.000038	0	0	0	< 0.000038	0.0000314 J	0	0.0000264 J	< 0.00004	0	< 0.000037	0			
NICKEL	umol/g	--	--		0	2	0	0	0	0	0	0	0	0	0	0			
RATIO OF SEM/AVS	mole ratio	--	--		< 0	< 0	< 0	< 0	< 0	< 0	< 0	< 0	< 0	< 0	< 0	< 0			
ZINC	umol/g	--	--		0	0	0	0	1	0	0	0	0	0	0	0			
General Chemistry																			
ACIDITY, TOTAL	mg/kg	--	--		12,500	27,700	30,800	33,300	--	32,000	38,500	--	35,200	--	20,400	21,800			
ALKALINITY, TOTAL (AS CACO3)	mg/kg	--	--		< 50	< 50	< 50	< 50	--	< 50	< 50	--	< 50	--	< 50	< 50			
ASHCONTENT	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	179,000	--			
BROMIDE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	< 20	--			
CHLORINE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	2,830	--			
CORROSIVITY	SU	--	--		--	--	--	--	--	--	--	--	--	--	1.09 J	--			
CYANIDE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	< 0.15	--			
DENSITY	g/cm3	--	--		--	--	--	--	--	--	--	--	--	--	1	--			
FLUORINE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	211	--			
GROSS CALORIFIC VALUE	BTU/lb	--	--		--	--	--	--	--	--	--	--	--	--	8670 J	--			
IGNITABILITY	Degrees F	--	--		--	--	--	--	--	--	--	--	--	--	128	--			
MOISTURE, PERCENT (D4017)	percent	--	--		--	--	--	--	--	--	--	--	--	--	25	--			
MOISTURE, PERCENT (D4643)	percent	--	--		--	--	--	--	--	--	--	--	--	--	33	--			
NITROGEN, AMMONIA (AS N)	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	7.9 J	--			
OXIDATION-REDUCTION POTENTIAL	mV	--	--		586	550	543	565	--	568	612	--	544	--	596	595			
PH	ph units	--	--		2	2	2	2	--	1	1	--	6	--	2	2			
SOLIDS, PERCENT	percent	--	--		--	--	--	--	--	--	--	--	--	--	67	--			
SULFIDE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	< 4.8 J	--			
SULFUR, PERCENT	percent	--	--		1														

Table 2

Caisson 2 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		Caisson #2		2/28/14- 5/19/14	CAISSON #2									6/4/2014	ROLL OFF				
Sample Date		11/12/2013			5/19/2014	5/27/2014										6/4/2014	Post Removal		
Treatment Stage		Pre Thermal (Raw Tar)			Post Thermal											Post Removal			
Core/Depth		0-1.2'	0-1.2'		Vibracore Attempt	A - 0-2'	A - 5-7'	A - 7-8.7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	C - 5-7'	C - 9-10'	Sample A	Sample B			
Parameter	Unit	112113-TAR-TC02-0012 (Encore)	112113-TAR-TC02-0012 (Terracore)		051914-TAR- TC02-000001	052714-HC- TC02A-000020	052714-HC- TC02A-050070	052714-HC- TC02A-070087	052714-TAR- TC02B-000027	052714-HC- TC02B027050	052714-HC- TC02B-08100	052714-TAR- TC02C-010032	052714-HC- TC02C-050070	052714-HC- TC02C-090100	060414-TAR- TC02A	060414-TAR- TC02B			
TOTAL ORGANIC CARBON	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	610000 J	--			

Notes:

-- = no sample taken

BTU/lb = British Thermal Units per pound

g/cm3=grams per cubic centimeter

ug/Kg = micrograms per kilogram

mg/Kg = milligrams per kilogram

umol/g = micromoles per gram

Degree F = Degrees Fahrenheit

mV = milivolt

SU = Standard Units

J = estimated detected result

NA = Not applicable

< = non-detected result

Detects are in **BOLD** font

Table 3

Caisson 3 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		CAISSON #3		CAISSON #3														ROLL OFF				
Sample Date		11/12/2013		5/28/2014												5/29/2014		6/4/2014				
Treatment Stage		PRE THERMAL (Raw Tar)		POST THERMAL (PRE ISS MIXING)												POST 1st MIX		POST REMOVAL (Pre 2nd MIX)				
Core/Depth	Parameter	Unit	0-1.2'	0-1.2'	A - 0.8-2.2'	A - 5-5.8'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	B - 5-7.6' Dup	B - 7-6.8'	C - 4-5'	C - 5-7'	C - 7-8'	5/29/2014	6/4/2014	Sample A	Sample B	Sample A	Sample B		
			112113-TAR-TC03-0012 (Encore)	112113-TAR-TC03-0012 (Terracore)	052814-TAR-TC03A-008022	052814-SWSM-TC03A-050058	052814-HC-TC03A-070082	052814-HC-TC03B-009016	052814-TAR-TC03B-050076	052814-TAR-TC03B-D	052814-HC-TC03B-076080	052814-HC-TC03C-040050	052814-SW-TC03C-050070	052814-HC-TC03C-070080			053014-PTM-TC03A-060080	053014-PTM-TC03B-060080	060414-TAR-TC03A	060414-TAR-TC03B	060414-TAR-TC03C	060414-TAR-TC03D
VOCs																						
1,1,1-TRICHLOROETHANE	ug/kg	< 6790	11600 J		< 150	< 150	< 260	< 200	< 45	< 170	< 2700	< 300	< 47	< 220			< 2000	< 2000	< 3300	< 1900		
1,1,2,2-TETRACHLOROETHANE	ug/kg	< 7320	< 7230		< 180	< 180	< 310	< 240	< 54	< 200	< 3200	< 360	< 56	< 260			< 2300	< 2400	< 3900	< 2300		
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	ug/kg	< 15600	< 15400		< 230	< 230	< 390	< 300	< 69	< 250	< 4100	< 450	< 71	< 340			< 3000	< 3100	< 4900	< 2900		
1,1,2-TRICHLOROETHANE	ug/kg	< 2690	< 2650		< 440	< 440	< 730	< 570	< 130	< 480	< 7700	< 850	< 130	< 640			< 5600	< 5800	< 9300	< 5500		
1,1-DICHLOROETHANE	ug/kg	< 4040	< 3990		< 170	< 170	< 280	< 220	< 50	< 180	< 2900	< 330	< 51	< 240			< 2200	< 2200	< 3600	< 2100		
1,1-DICHLOROETHENE	ug/kg	< 9510	< 9390		< 150	< 150	< 260	< 200	< 45	< 170	< 2700	< 300	< 47	< 220			< 2000	< 2000	< 3300	< 1900		
1,2,3-TRICHLOROBENZENE	ug/kg	< 15100	< 14900		< 110	< 110	< 190	< 140	< 33	< 120	< 1900	< 220	< 34	< 160			< 1400	< 1500	< 2300	< 1400		
1,2,4-TRICHLOROBENZENE	ug/kg	< 12800	< 12600		997 J	430 J	512 J	< 130	< 29	< 110	< 1700	< 190	< 30	< 140			< 1200	< 1300	< 2100	< 1200		
1,2-DIBROMO-3-CHLOROPROPANE	ug/kg	< 11900	< 11800		< 720	< 700	< 1200	< 920	< 210	< 770	< 12000	< 1400	< 220	< 1000			< 9100	< 9400	< 15000	< 8800		
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ug/kg	< 8630	< 8520		< 300	< 290	< 490	< 380	< 87	< 320	< 5100	< 570	< 89	< 420			< 3800	< 3900	< 6200	< 3600		
1,2-DICHLOROBENZENE	ug/kg	1650000	2,980,000		280,000	105,000	171,000	10,100	2,220	24,400	1,530,000	46,400	2,010	104,000			115,000	112,000	131,000	113,000		
1,2-DICHLOROETHANE	ug/kg	< 8300	< 8190		< 170	< 170	< 290	< 220	< 51	< 190	< 3000	< 330	< 52	< 250			< 2200	< 2300	< 3600	< 2100		
1,2-DICHLOROPROPANE	ug/kg	< 3190	< 3150		< 230	< 230	< 390	< 300	< 69	< 250	< 4100	< 450	< 71	< 340			< 3000	< 3100	< 4900	< 2900		
1,3-DICHLOROBENZENE	ug/kg	27400 J	46000 J		3,720	1390 J	2430 J	< 150	< 35	354 J	28200 J	521 J	< 36	1220 J			1880 J	1800 J	2500	1560 J		
1,4-DICHLOROBENZENE	ug/kg	139000 J	236,000		22,000	8,280	14,400	719 J	154 J	2100 J	153,000	3410 J	135 J	7,640			8750 J	8370 J	9900 J	< 1700		
1,4-DIOXANE (P-DIOXANE)	ug/kg	--	--		< 41000	< 40000	< 68000	< 53000	< 12000	< 44000	< 720000	< 79000	< 12000	< 59000			< 520000	< 540000	< 870000	< 510000		
2-HEXANONE	ug/kg	< 12400	< 12200		< 960	< 940	< 1600	< 1200	< 280	< 1000	< 17000	< 1900	< 290	< 1400			< 12000	< 13000	< 20000	< 12000		
ACETONE	ug/kg	< 12400	67700 J		3890 J	< 2400 J	12000 J	< 3100	1,680	3580 J	74400 J	< 4700 J	3,890	5890 J			< 31000	< 32000	< 52000	< 30000		
BENZENE	ug/kg	65700000	68,200,000		123,000	118,000	308,000	18,600	20,200	243,000	61,900,000	39,600	20,100	226,000			2,310,000	2,310,000	1,830,000	1,320,000		
BROMOCHLOROMETHANE	ug/kg	< 13900	< 13700		< 280	< 270	< 460	< 360	< 82	< 300	< 4900	< 540	< 85	< 400			< 3600	< 3700	< 5900	< 3500		
BROMODICHLOROMETHANE	ug/kg	< 4340	< 4290		< 150	< 150	< 250	< 190	< 45	< 160	< 2600	< 290	< 46	< 220			< 1900	< 2000	< 3200	< 1900		
BROMOFORM	ug/kg	< 18300	< 18100		< 140	< 140	< 230	< 180	< 42	< 150	< 2500	< 270	< 43	< 200			< 1800	< 1800	< 3000	< 1700		
BROMOMETHANE	ug/kg	< 20400	< 20100		< 260	< 250	< 430	< 330	< 76	< 280	< 4500	< 500	< 78	< 370			< 3300	< 3400	< 5500	< 3200		
CARBON DISULFIDE	ug/kg	84100 J	95100 J		393 J	1050 J	1140 J	407 J	605 J	4,160	73,200	347 J	381 J	1580 J			< 970	< 990	< 1600	< 940		
CARBON TETRACHLORIDE	ug/kg	< 7900	< 7800		< 140	< 130	< 220	< 170	< 40	< 150	< 2400	< 260	< 41	< 190			< 1700	< 1800	< 2800	< 1700		
CHLOROBENZENE	ug/kg	15000 J	29100 J		513 J	195 J	267 J															

Table 3

Caisson 3 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		CAISSON #3		CAISSON #3										ROLL OFF			
Sample Date		11/12/2013		5/28/2014										5/29/2014			
Treatment Stage		PRE THERMAL (Raw Tar)		POST THERMAL (PRE ISS MIXING)										6/4/2014			
Core/Depth	Parameter	Unit	0-1.2'	0-1.2'	A - 0.8-2.2'	A - 5-5.8'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	B - 5-7.6' Dup	B - 7-6.8'	C - 4-5'	C - 5-7'	C - 7-8'	6/4/2014	6/4/2014	
	112113-TAR-TC03-0012 (Encore)	112113-TAR-TC03-0012 (Terracore)	2/28/14-5/19/14		052814-TAR-TC03A-008022	052814-SWSM-TC03A-050058	052814-HC-TC03A-070082	052814-HC-TC03B-009016	052814-TAR-TC03B-050076	052814-TAR-TC03B-D	052814-HC-076080	052814-HC-040050	052814-SW-TC03C-050070	052814-HC-070080	5/29/2014	5/29/2014	
2,4,6-TRICHLOROPHENOL	ug/kg	--	< 45700		< 250	< 250	< 220	< 200	< 35	< 180	< 220	< 220	< 43 J	< 190	053014-PTM-TC03A-060080	053014-PTM-TC03B-060080	
2,4-DICHLOROPHENOL	ug/kg	--	< 37300		< 430	< 420	< 380 J	< 340	< 59 J	< 310	< 380 J	< 380	< 73 J	< 330	< 320	< 640	
2,4-DIMETHYLPHENOL	ug/kg	--	< 25700		4,010	5,590	4,110	463 J	567	< 330	< 400	1,540	522	< 350	3,130	3,670	
2,4-DINITROPHENOL	ug/kg	--	< 88600		< 330	< 320	< 290	< 260	< 45	< 240	< 290	< 55 J	< 250	< 410	< 830		
2,4-DINITROTOLUENE	ug/kg	--	< 26400		< 120	< 110	< 100	< 94	< 16	< 85	< 100	< 100	< 20 J	< 90	< 150	< 300	
2,6-DINITROTOLUENE	ug/kg	--	< 48400		< 100	< 100	< 89	< 82	< 14	< 74	< 90	< 90	< 17 J	< 79	< 130	< 260	
2-CHLORONAPHTHALENE	ug/kg	--	< 41300		< 84	< 81	< 73	< 66	< 11	< 60	< 73	< 74	< 14 J	< 64	< 100	< 210	
2-CHLOROPHENOL	ug/kg	--	< 28500		< 270	< 260	< 230	< 210	< 37	< 190	< 240	< 240	< 45 J	< 210	< 340	< 680	
2-METHYLNAPHTHALENE	ug/kg	--	463000 J		92,300	156,000	118,000	20,300	14,200	10,100	143,000	72,300	26,700	62,700	146,000	171,000	
2-METHYLPHENOL (O-CRESOL)	ug/kg	--	< 40100		1,260	1,810	449 J	269 J	227	< 220	< 270	612	465	< 230	< 390	1300 J	< 650
2-NITROANILINE	ug/kg	--	< 16500		< 120	< 120	< 100	< 94	< 16	< 85	< 100	< 100	< 20 J	< 91	< 150	< 300	
2-NITROPHENOL	ug/kg	--	< 46400		< 290	< 280	< 250 J	< 230	< 39 J	< 210	< 250 J	< 250	< 48 J	< 220	< 360	< 720	
3- AND 4- METHYLPHENOL (TOTAL)	ug/kg	--	--		4,260	6,060	3,920	875	703	502	< 300	2,080	872	1,630	2,740	< 860	
3,3'-DICHLOROBENZIDINE	ug/kg	--	< 124000		< 68	< 66	< 60	< 54	< 9.4	< 49	< 60	< 60	< 11 J	< 52	< 86	< 170	
3-NITROANILINE	ug/kg	--	< 17700		< 110	< 100	< 94	< 86	< 15	< 78	< 95	< 95	< 18 J	< 82	< 140	< 270	
4,6-DINITRO-2-METHYLPHENOL	ug/kg	--	< 70100		< 330	< 320	< 290	< 260	< 45	< 240	< 290	< 55 J	< 250	< 410	< 830		
4-BROMOPHENYL PHENYL ETHER	ug/kg	--	< 41300		< 98	< 95	< 85	< 78	< 13	< 70	< 86	< 86	< 16 J	< 75	< 120	< 250	
4-CHLORO-3-METHYLPHENOL	ug/kg	--	< 29200		< 270	< 260	< 230 J	< 210	< 37 J	< 190	< 240 J	< 240	< 45 J	< 210	< 340	< 680	
4-CHLOROANILINE	ug/kg	--	< 25000		< 86	< 84	< 75 J	< 69	< 12 J	< 62	< 76 J	< 76	< 14 J	< 66	< 110	< 220	
4-CHLOROPHENYL PHENYL ETHER	ug/kg	--	< 28900		< 81	< 79	< 71	< 64	< 11	< 58	< 71	< 71	< 14 J	< 62	< 100	< 200	
4-NITROANILINE	ug/kg	--	< 16700		< 110	< 100	< 92	< 84	< 14	< 76	< 92	< 93	< 18 J	< 80	< 130	< 260	
4-NITROPHENOL	ug/kg	--	< 82600		< 460	< 440	< 400	< 360	< 62	< 330	< 400	< 400	< 77 J	< 350	< 570	< 1100	
ACENAPHTHENE	ug/kg	--	< 39700		20,300	8,170	4,030	918	630	< 56	2,820	4,270	950	3,170	9,620	10,400	
ACENAPHTHYLENE	ug/kg	--	< 26600		< 86	< 84	< 75	< 69	< 12	< 62	< 76	< 76	< 14 J	< 66	< 110	< 220	
ACETOPHENONE	ug/kg	--	725000 J		59,500	83,500	61,500	11,500	9,340	6,630	239,000	29,300	14,400	31,000	97,500	118,000	
ANILINE	ug/kg	--	< 88600		13800 J	12,800	< 470 J	1070 J	< 74 J	< 390 J	< 470 J	< 470 J	< 91 J	< 410 J	7,860	16,100	
ANTHRACENE	ug/kg	--	< 26700		< 94	< 91	< 82	< 75	< 13	< 68	< 83	< 83	< 16 J	< 72	< 120	< 240	
ATRAZINE	ug/kg	--	< 27300		< 53	< 52	< 46	< 42	< 7.3	< 38	< 47	< 47	< 8.9 J	< 41	< 67	< 130	
BENZALDEHYDE	ug/kg	--	< 126000		< 62	< 60	< 54	< 49	< 8.5	< 45	< 55	< 55	< 10 J	< 47	< 78	< 160	
BENZO(A)ANTHRACENE	ug/kg	--	< 24200	T	984	3,400	476	372	176	218	751	736	698	403	1,400	2,070	
BENZO(A)PYRENE	ug/kg	--	< 16300	H	< 82	< 80	< 72 J	< 65	< 11	< 59	< 72 J	< 72	< 14 J	< 63	< 100	< 210	
BENZO(B)FLUORANTHENE	ug/kg	--	< 25700	R	< 90	< 87	< 78 J	< 72	< 12	< 65	< 79 J	< 79	< 15 J	< 69	< 110	< 230	
BENZO(G,H,I)PERYLENE	ug/kg	--	< 19600	M	< 100	< 97	< 87 J	< 80	< 14	< 72	< 88 J	< 88	< 17 J	< 77	< 130	< 250	
BENZO(K)FLUORANTHENE	ug/kg	--	< 20100	A	< 100	< 98	< 88 J	< 81	< 14	< 73	< 89 J	< 89	< 17 J	< 77	< 130	< 250	
BENZYL BUTYL PHTHALATE	ug/kg	--	< 25900	L	< 160	< 150	< 140	< 120	< 21	< 110	< 140	< 140	< 26 J	< 120	< 200	< 390	
BIPHENYL (DIPHENYL)	ug/kg</																

Table 3

Caisson 3 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		CAISSON #3		CAISSON #3														ROLL OFF	
Sample Date		11/12/2013		5/28/2014												5/29/2014		6/4/2014	
Treatment Stage		PRE THERMAL (Raw Tar)		POST THERMAL (PRE ISS MIXING)												POST 1st MIX		POST REMOVAL (Pre 2nd MIX)	
Core/Depth		0-1.2'		0-1.2'												Sample A		Sample A	
Parameter	Unit	112113-TAR-TC03-0012 (Encore)	112113-TAR-TC03-0012 (Terracore)	2/28/14-5/19/14	A - 0.8-2.2'	A - 5-5.8'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	B - 5-7.6' Dup	B - 7-6.8'	C - 4-5'	C - 5-7'	C - 7-8'	5/29/2014	6/4/2014	6/4/2014	6/4/2014	
N-NITROSODI-N-PROPYLAMINE	ug/kg	--	< 56700	< 66	< 64	< 57	< 52	< 9	< 47	< 58	< 58	< 11 J	< 50	< 82	255 J	< 140	< 30	< 32	< 26
N-NITROSODIPHENYLAMINE	ug/kg	--	< 27500	< 160	< 160	< 140	< 130	< 22	< 120	< 140	< 140	< 27 J	< 120	< 200	< 400	< 340	< 74	< 79	< 64
PENTACHLOROPHENOL	ug/kg	--	< 29100	< 460	< 450	< 400	< 370	< 63	< 330	< 410	< 410	< 77 J	< 350	< 580	< 1200	< 970	< 210	< 220	< 180
PHENANTHRENE	ug/kg	--	< 29800	18,800	38,500	9,980	5,220	3,080	3,050	13,300	14,900	10,600	8,910	17,500	24,500	22,800	10,800	11,500	7,180
PHENOL	ug/kg	--	< 35800	< 280	< 270	< 250	993	801	< 200	< 250	2,100	< 48 J	661	< 350	< 710	< 590	1,910	< 140	< 110
PYRENE	ug/kg	--	< 18200	704	< 100	309	190 J	< 14	371	< 91	1,700	1730 J	547	< 130	< 260	1,560	697	819	503
PCBs																			
PCB, TOTAL	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 14	--
PCB-1016 (Aroclor 1016)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 23 J	--
PCB-1221 (Aroclor 1221)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 30	--
PCB-1232 (Aroclor 1232)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 34 J	--
PCB-1242 (Aroclor 1242)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 24 J	--
PCB-1248 (Aroclor 1248)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 22	--
PCB-1254 (Aroclor 1254)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 22 J	--
PCB-1260 (Aroclor 1260)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 18 J	--
PCB-1268 (Aroclor 1268)	ug/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 14 J	--
Metals																			
ALUMINUM	mg/kg	--	106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13,100	--
ANTIMONY	mg/kg	--	< 0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.9 J	--
ARSENIC	mg/kg	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	18	--
BARIUM	mg/kg	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	127	--
BERYLLIUM	mg/kg	--	< 0.052	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CADMIUM	mg/kg	--	< 0.065	< 0.01	< 0.01	< 0.0089	0.086 J	< 0.0072	< 0.0073	< 0.0092	< 0.0095	< 0.0088	< 0.0082	< 0.063	< 0.067	< 0.11	< 0.12	< 0.13	--
CALCIUM	mg/kg	--	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	121,000	--
CHROMIUM, TOTAL	mg/kg	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	21	--
COBALT	mg/kg	--	0.29 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.1 J	--
COPPER	mg/kg	--	25	0.23 J	0.47 J	0.67 J	0.41 J	0.21 J	0.14 J	3	0.1 J	0.56 J	0.17 J	3	3	2	0.14 J	5	--
IRON	mg/kg	--	2,630	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9,280	--
LEAD	mg/kg	--	59	11	16	17	5	10	8	14	18	36	23	24	30	30	25	41	--
MAGNESIUM	mg/kg	--	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,750	--
MANGANESE	mg/kg	--	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	295	--
MERCURY	mg/kg	--	2	< 0.0032	< 0.0032	< 0.0028	0	0.0025 J	0	0	0	0.0055 J	0	< 0.0041	< 0.0043	0	0.0052 J	0	--
NICKEL	mg/kg	--	6	2	3	3	7	1.1 J	0.85 J	2	2	2	6	7	8	8	6	13	--
POTASSIUM	mg/kg	--	22.1 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,240	--
SELENIUM	mg/kg	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--
SILVER	mg/kg	--	< 0.13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--
SODIUM	mg/kg	--	1,510	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,620	--
THALLIUM	mg/kg	--	< 0.26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.42	--
VANADIUM	mg/kg	--	0.87 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17	--
ZINC	mg/kg	--	24	3	5	9	2	2	2	4	3	3	7	13	14	0	0	1	--
AVS/SEM																			
ACID VOLATILE SULFIDE	umol/g	--	--	< 0.08	< 0.08	< 0.07	< 0.06	< 0.06	< 0.07	< 0.08	< 0.07	< 0.07	< 0.07	1	18	0	15	< 0.1	--
CADMIUM	umol/g	--	--	< 0.0014	< 0.0014	< 0.0012	0.000765 J	< 0.0011	< 0.0011	< 0.0013	< 0.0013	<							

Table 3

Caisson 3 Analytical Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - Normal Results

Location		CAISSON #3		CAISSON #3												ROLL OFF				
Sample Date		11/12/2013		5/28/2014												6/4/2014				
Treatment Stage		PRE THERMAL (Raw Tar)												5/29/2014		6/4/2014				
Core/Depth		POST THERMAL (PRE ISS MIXING)												POST 1st MIX		POST REMOVAL (Pre 2nd MIX)				
Parameter	Unit	112113-TAR-TC03-0012 (Encore)	112113-TAR-TC03-0012 (Terracore)	2/28/14-5/19/14	A - 0.8-2.2'	A - 5-5.8'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	B - 5-7.6' Dup	B - 7-6.8'	C - 4-5'	C - 5-7'	C - 7-8'	Sample A	Sample B	Sample A	Sample B		
MOISTURE, PERCENT (D4017)	percent	--	--		--	--	--	--	--	--	--	--	--	--	053014-PTM-TC03A-060080	053014-PTM-TC03B-060080	060414-TAR-TC03A	060414-TAR-TC03B		
MOISTURE, PERCENT (D4643)	percent	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	34	--	
NITROGEN, AMMONIA (AS N)	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	41	--	
OXIDATION-REDUCTION POTENTIAL	mV	--	--		577	--	584	581	605	--	--	563	593	--	(168)	414	--	--	13	--
PH	ph units	--	--		2	--	1	2	1	--	--	2	2	--	12	13	--	--	67	--
SOLIDS, PERCENT	percent	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	59	--	
SULFIDE	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	< 4.8 J	--	
SULFUR, PERCENT	percent	--	--		4	11	13	11	14	14	22	11	8	13	9	5	--	--	34200 J	--
SULFUR, MOL (S8)	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	170000 J	--
TOTAL ORGANIC CARBON	mg/kg	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

-- = no sample taken

BTU/lb = British Thermal Units per pound

g/cm3=grams per cubic centimeter

ug/kg = micrograms per kilogram

mg/Kg = milligrams per kilogram

umol/g = micromoles per gram

Degree F = Degrees Fahrenheit

mV = millivolt

SU = Standard Units

J = estimated detected result

NA = Not applicable

< = non-detected result

Detects are in **BOLD** font

Table 4

Summary of Impoundment Material Data

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Summary

		Pre-Treatment (Raw Tar)						Post ISTT						Post 1st Mix						Post Removal						Post 2nd Mix									
		Range		Median	Average	Std. Dev.	Notes	Range		Median	Average	Std. Dev.	Notes	Range		Median	Average	Std. Dev.	Notes	Range		Median	Average	Std. Dev.	Notes	Range		Median	Average	Std. Dev.	Notes				
		Low	High					Low	High					Low	High					Low	High					Low	High								
Caisson #2	Units																																		
Chemical Parameters																																			
Benzene	mg/kg	95,800	96,400	96,100	96,100	424		3,160	11,000	4,450	5,775	2,911		--	--	--	--	No ISS on Caisson 2	4,100	8,140	6,120	6,120	2,857		--	--	--	--	--	No ISS on Caisson 2					
Total VOCs	mg/kg	125,220	133,644	129,432	129,432	5,956		6,005	15,660	8,097	9,552	3,667		--	--	--	--		6,834	12,113	9,474	9,474	3,733		--	--	--	--	--						
Naphthalene	mg/kg	22,000	22,000	22,000	22,000	N/A	One Value	1,550	8,290	3,500	3,817	2,114		--	--	--	--		2,330	5,840	4,085	4,085	2,482		--	--	--	--	--						
TCLP Benzene	mg/L	399	399	399	399	N/A	One Value	48	198	86	106	57		--	--	--	--		66	177	122	122	0.078		--	--	--	--	--						
SPLP Benzene	mg/L	439	439	439	439	N/A	One Value	29	170	63	68	50							89	144	116	116	39		--	--	--	--	--						
Caisson #3	Units																																		
Chemical Parameters																																			
Benzene	mg/kg	65,700	68,200	66,950	66,950	1,768		19	61,900	118	6,975	20,597		2,310	2,310	2,310	2,310	-	2 identical values	1,320	1,830	1,575,000	1,575	361		2,490	2,490	2,490	2,490	N/A	One Value				
Total VOCs	mg/kg	84,034	92,121	88,078	88,078	5,719		34	76,502	389	8,833	25,378		3,002	3,032	3,017	3,017	21		1,890	2,561	2,225,475	2,225	474		3,543	3,543	3,543	3,543	N/A	One Value				
Naphthalene	mg/kg	9,690	9,690	9,690	9,690	N/A	One Value	273	3,690	884	1,388	1,195		2,290	2,680	2,485	2,485	276		1,070	1,710	1,390,000	1,390	453		1,740	1,740	1,740	1,740	N/A	One Value				
TCLP Benzene	mg/L	526	526	526	526	N/A	One Value	0.281	12	86	3	5		85	85	85	85	18		--	--	--	--	--	No Data	59	59	59	59	N/A	One Value				
SPLP Benzene	mg/L	531	531	531	531	N/A	One Value	0.085	10	63	2	4		87	132	110	110	32		--	--	--	--	--	No Data	59	59	59	59	N/A	One Value				

Table 5

TCLP Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - TCLP Results

Location		CAISSON 2									
Sample Date		11/12/2013	5/19/2014	5/27/2014						6/4/2014	
Treatment Stage		PRE THERMAL (RAW TAR)	POST THERMAL	POST THERMAL						POST REMOVAL	
Core/Depth		0-1.2'	0-0.1'	A - 0-2'	A - 5-7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	Sample A	Sample B
Parameter	Unit	112113-TAR- TC02-00012	051914-TAR- TC02-000001	052714-HC- TC02A-000020	052714-HC- TC02A-000070	052714-TAR- TC02B-000027	052714-HC- TC02B-027050	052714-HC- TC02B-	052714-TAR- TC02C-010032	060414-TAR- TC02A	060414-TAR- TC02B
TCLP VOCs											
1,1-DICHLOROETHENE	mg/L	< 1	< 0.0017	< 0.17	< 0.0017 J	< 0.086	< 0.086	< 0.34	< 0.17	< 0.0017	< 0.17
1,2-DICHLOROETHANE	mg/L	< 0.581	< 0.0011	< 0.11	< 0.0011 J	< 0.055	< 0.055	< 0.22	< 0.11	< 0.0011	< 0.11
1,4-DICHLOROBENZENE	mg/L	--	0.092	< 0.15	0.1 J	< 0.075	< 0.075	< 0.3	< 0.15	0.0934	< 0.15
BENZENE	mg/L	399	86.2	77.2	198	47.8	54.2	166	110	66.2	177
CARBON TETRACHLORIDE	mg/L	< 1.24	< 0.0011	< 0.11	< 0.0011 J	< 0.057	< 0.057	< 0.23	< 0.11	< 0.0011	< 0.11
CHLOROBENZENE	mg/L	< 0.414	0.0156	< 0.17	0.021 J	< 0.087	< 0.087	< 0.35	< 0.17	0.0166	< 0.17
CHLOROFORM	mg/L	< 0.775	0.0013 J	< 0.12	0.0067 J	< 0.061	< 0.061	< 0.25	< 0.12	< 0.0012	< 0.12
NAPHTHALENE	mg/L	<0.881	--	--	--	--	--	--	--	--	--
METHYL ETHYL KETONE (2-BUTANONE)	mg/L	< 0.711	0.0707 J	< 1.6	0.256 J	< 0.8	< 0.8	< 3.2	< 1.6	0.0551 J	< 1.6
TETRACHLOROETHYLENE (PCE)	mg/L	< 0.963	< 0.0013	< 0.13	< 0.0013 J	< 0.063	< 0.063	< 0.25	< 0.13	< 0.0013	< 0.13
TRICHLOROETHYLENE (TCE)	mg/L	< 0.807	< 0.0025	< 0.25	< 0.0025 J	< 0.13	< 0.13	< 0.51	< 0.25	< 0.0025	< 0.25
VINYL CHLORIDE	mg/L	< 0.636	< 0.0026	< 0.26	< 0.0026 J	< 0.13	< 0.13	< 0.51	< 0.26	< 0.0026	< 0.26
TCLP SVOCs											
1,4-DICHLOROBENZENE	mg/L	< 0.0245	0.0547	0.0354 J	0.0466	0.0508	0.035	0.0464	0.0563	0.0492	0.038
2,4,5-TRICHLOROPHENOL	mg/L	< 0.0134	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
2,4,6-TRICHLOROPHENOL	mg/L	< 0.0162	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013
2,4-DINITROTOLUENE	mg/L	< 0.0141	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043
2-METHYLPHENOL (O-CRESOL)	mg/L	< 0.0126	0.0301	0.0368	0.0389	0.0496	0.039	0.0317	0.0477	0.0397	0.0392
3- AND 4- METHYLPHENOL (TOTAL)	mg/L	--	0.115	0.189	0.288	0.457	0.47	0.197	0.423	0.387	0.259
CRESOL	mg/L	<0.0215	--	--	--	--	--	--	--	--	--
HEXACHLOROBENZENE	mg/L	< 0.025	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034
HEXACHLOROBUTADIENE	mg/L	< 0.0245	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051
HEXACHLOROETHANE	mg/L	< 0.0238	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055
M,P-CRESOL		<0.0088	--	--	--	--	--	--	--	--	--
NITROBENZENE	mg/L	< 0.019	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042
PENTACHLOROPHENOL	mg/L	< 0.0144	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014
PYRIDINE	mg/L	0.307 J	0.378	0.168	0.245	3.98	7.69	0.222	3.37	0.19	0.159 J
TCLP Metals											
ARSENIC	mg/L	< 0.025	< 0.0026	0.062 J	0.033 J	< 0.0026	< 0.0026	< 0.0026	< 0.0026	0.0093 J	0.0071 J
BARIUM	mg/L	< 0.013	0.039 J	0.031 J	0.031 J	0.032 J	0.03 J	0.036 J	0.038 J	0.032 J	0.032 J
CADMIUM	mg/L	< 0.0063	0.0027 J	0.0015 J	0.0018 J	< 0.0007	0.0014 J	< 0.0014	0.0015 J	0.0038 J	0.0046 J
CHROMIUM, TOTAL	mg/L	0.03 J	0.76	0.88	1.1	0.37	0.77	1.2	0.62	0.68	0.91
LEAD	mg/L	0.12 J	0.35 J	0.56	0.49 J	0.43 J	0.98	0.39 J	0.55	0.73	0.53
MERCURY	mg/L	0.00038 J	0.000071 J	< 0.000064	< 0.000064	0.00007 J	0.000069 J	0.00012 J	0.00013 J	< 0.000064	
SELENIUM	mg/L	< 0.05	0.0039 J	< 0.0036	< 0.0036	< 0.0036	< 0.0036	< 0.0036	< 0.0036	0.0046 J	0.0039 J
SILVER	mg/L	< 0.013	< 0.0012	< 0.0025	0.0027 J	0.0024 J	< 0.0012	0.03	< 0.0012	< 0.0012	0.012 J

CAISSON 3									
11/12/2013	5/28/2014						5/30/2014		6/4/2014
PRE THERMAL (RAW TAR)	POST THERMAL (PRE ISS MIXING)						POST 1st MIX		POST 2nd MIX
0-1.2'	A - 0.8-2.2'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	C - 4-5'	C - 5-7'	A - 6-8'	B - 6-8'	Sample C
112113-TAR- TC03-0012	052814-TAR- TC03A-008022	052814-HC- TC03A-070082	052814-HC- TC03B-009016	052814-TAR- TC03B-050076	052814-HC- TC03C-040050	052814-SW- TC03C-050070	053014-PTM- TC03A-060080	053014-PTM- TC03B-060080	060414-TAR-TC0
< 1	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.
< 0.581	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.
--	0.0723	0.0477	0.0053	< 0.0015	0.0043 J	< 0.0015	0.072	0.0707	< 0.
526	3	11.6	0.448	0.401	0.281	< 0.0823	84.7	84.9	5
< 1.24	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.
< 0.414	0.0066	0.0038 J	< 0.0017	< 0.0017	< 0.0017	< 0.0017	0.0133	0.0131	< 0.
< 0.775	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	0.0035 J	0.0035 J	< 0.
<0.881	--	--	--	--	--	--	--	--	--
< 0.711	< 0.016	0.0633 J	< 0.016	< 0.016	< 0.016	< 0.016	0.0224 J	0.0284 J	< 0.
< 0.963	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.
< 0.807	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.
< 0.636	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.
< 0.0245	0.0246	0.0171 J	< 0.0036	< 0.0036	< 0.0036	< 0.0036	0.0246	0.0261	0.02
< 0.0134	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.
< 0.0162	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.013	< 0.
< 0.0141	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.0043	< 0.
< 0.0126	0.0414	0.0123 J	< 0.01	< 0.01	< 0.01	< 0.01	0.0208	0.0222	0.012
--	0.1	0.124	0.0176 J	< 0.0093	0.0261	< 0.0093	0.0453	0.046	0.03
<0.215	--	--	--	--	--	--	--	--	--
< 0.025	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.0034	< 0.
< 0.0245	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.0051	< 0.
< 0.0238	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.0055	< 0.
<0.088	--	--	--	--	--	--	--	--	--
< 0.019	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.0042	< 0.
< 0.0144	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.
0.646	0.223	4.33	0.464	1.26	0.204	< 0.0032	0.329	0.0462	0.2
< 0.025	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	0.01
< 0.013	0.054 J	0.023 J	0.04 J	0.026 J	0.051 J	0.037 J	0.27 J	0.28 J	0.7
< 0.0063	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007	0.0009 J	0.0011 J	< 0.
0.13 J	0.14	0.25	0.11	0.28	0.092	0.12	< 0.00089	0.0016 J	< 0.
0.29 J	0.32 J	0.8	0.38 J	0.42 J	0.37 J	0.55	0.0068 J	0.0064 J	< 0.
0.00023 J	< 0.000064	< 0.000064	< 0.000064	< 0.000064	< 0.000064	< 0.000064	0.000074 J	0.00008 J	0.0000
< 0.05	0.0038 J	0.0092 J	0.0042 J	0.0041 J	0.0043 J	0.0056 J	0.036 J	0.035 J	< 0.
< 0.013	0.0042 J	0.0046 J	0.0037 J	0.0044 J	0.0028 J	0.003 J	0.033	0.032	0.0

Notes

-- = no sample taken

mg/L = miligram per liter

J = estimated detected result

< = non-detected result

Detects are in **BOLD** font

Table 6

SPLP Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - SPLP Results

Location		CAISSON 2										CAISSON 3									
Sample Date		11/12/2013	5/19/2014	5/27/2014						6/4/2014						5/28/2014					
Treatment Stage		PRE THERMAL (RAW TAR)		POST THERMAL						POST REMOVAL						POST THERMAL (PRE ISS MIXING)					
Core/Depth	0-1.2'	0-0.1'	A - 0-2'	A - 5-7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	Sample A	Sample B	0-0.1'	A - 0.8-2.2'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	C - 4-5'	C - 5-7'	A - 6-8'	B - 6-8'	Sample C	
Parameter	Unit	112113-TAR- TC02-00012	051914-TAR- TC02A-000001	052714-HC- TC02A-050070	052714-HC- TC02B-000027	052714-TAR- TC02B-027050	052714-HC- TC02C-010032	052714-TAR- TC02A	060414-TAR- TC02B	060414-TAR- TC02A	052814-TAR- TC03-00012	052814-HC- TC03A-008022	052814-HC- TC03A-070082	052814-TAR- TC03B-009016	052814-HC- TC03B-050076	052814-SW- TC03C-040050	053014-PTM- TC03C-050070	053014-PTM- TC03A-060080	060414-TAR- TC03B-060080	060414-TAR- TC03C	
SPLP VOCs																					
1,1,1-TRICHLOROETHANE	mg/L	ND	< 0.012	< 0.025	< 0.05	< 0.025	< 0.025	< 0.05	< 0.00025 J	< 0.00025 J	ND	< 0.0025	< 0.012	< 0.0005	< 0.0005	< 0.0005	< 0.00025	< 0.025	< 0.0025	< 0.062	
1,1,1,2-TETRACHLOROETHANE	mg/L	ND	--	--	--	--	--	--	--	--	ND	< 0.002	< 0.0098	< 0.00039	< 0.00039	< 0.00039	< 0.0002	< 0.02	< 0.002	< 0.049	
1,1,2,2-TETRACHLOROETHANE	mg/L	ND	< 0.0098	< 0.02	< 0.039	< 0.02	< 0.02	< 0.039	< 0.0002 J	< 0.0002 J	ND	< 0.0077	< 0.038	< 0.0015	< 0.0015	< 0.00077	< 0.077	< 0.0077	< 0.19		
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	mg/L	ND	< 0.038	< 0.077	< 0.15	< 0.077	< 0.15	< 0.15	< 0.00077 J	< 0.00077 J	ND	< 0.0021	< 0.011	< 0.00042	< 0.00042	< 0.00021	< 0.021	< 0.0021	< 0.053		
1,1,2-TRICHLOROETHANE	mg/L	ND	< 0.011	< 0.021	< 0.042	< 0.021	< 0.021	< 0.042	< 0.00021 J	< 0.00021 J	ND	< 0.0026	< 0.013	< 0.00052	< 0.00052	< 0.00026	< 0.026	< 0.0026	< 0.065		
1,1-DICHLOROETHANE	mg/L	ND	< 0.013	< 0.026	< 0.052	< 0.026	< 0.052	< 0.052	< 0.00026 J	< 0.00026 J	ND	< 0.0034	< 0.017	< 0.00069	< 0.00069	< 0.00034	< 0.034	< 0.034	< 0.086		
1,1-DICHLOROETHENE	mg/L	ND	< 0.017	< 0.034	< 0.034	< 0.034	< 0.069	< 0.069	< 0.00034 J	< 0.00034 J	ND	--	--	--	--	--	--	--	--		
1,1-DICHLOROPROPENE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,3-DICHLOROPROPANE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
2,2-DICHLOROPROPANE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,2,3-TRICHLOROBENZENE	mg/L	--	< 0.012	< 0.024	< 0.049	< 0.024	< 0.024	< 0.049	< 0.00024 J	< 0.00024 J	--	< 0.0024	< 0.012	< 0.00049	< 0.00049	< 0.00049	< 0.00024	< 0.024	< 0.0024	< 0.061	
1,2,4-TRICHLOROBENZENE	mg/L	ND	< 0.011	< 0.022	< 0.043	< 0.022	< 0.022	< 0.043	< 0.00083 J	< 0.00078 J	ND	< 0.0022	< 0.011	< 0.00043	< 0.00043	< 0.00043	< 0.00022	< 0.022	< 0.0022	< 0.054	
1,2,3-TRICHLOROPROPANE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,2,4-TRIMETHYLBENZENE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,3,5-TRIMETHYLBENZENE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,2-DIBROMO-3-CHLOROPROPANE	mg/L	ND	< 0.063	< 0.13	< 0.25	< 0.13	< 0.25	< 0.25	< 0.0013 J	< 0.0013 J	ND	< 0.013	< 0.063	< 0.0025	< 0.0025	< 0.0025	< 0.0013	< 0.13	< 0.013	< 0.32	
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	mg/L	ND	< 0.008	< 0.016	< 0.032	< 0.016	< 0.016	< 0.032	< 0.00016 J	< 0.00016 J	ND	< 0.0016	< 0.008	< 0.00032	< 0.00032	< 0.00032	< 0.00016	< 0.016	< 0.0016	< 0.04	
1,2-DICHLOROBENZENE	mg/L	1.19 J	1.21	0.894	1.12	0.783	0.627	1.17	1.31	1.16	1.18	1.37 J	0.52	0.397	0.0978	0.0089	0.0971	0.00044 J	0.965	0.843	0.743
1,2-DICHLOROETHANE	mg/L	ND	< 0.011	< 0.022	< 0.044	< 0.022	< 0.022	< 0.044	< 0.00022 J	< 0.00022 J	ND	< 0.0022	< 0.011	< 0.00044	< 0.00044	< 0.00044	< 0.00022	< 0.022	< 0.0022	< 0.055	
1,2-DICHLOROETHENE (TOTAL)	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
1,2-DICHLOROPROPANE	mg/L	ND	< 0.014	< 0.028	< 0.056	< 0.028	< 0.028	< 0.056	< 0.00028 J	< 0.00028 J	ND	< 0.0028	< 0.014	< 0.00056	< 0.00056	< 0.00056	< 0.00028	< 0.028	< 0.0028	< 0.07	
1,3-DICHLOROBENZENE	mg/L	ND	0.0182 J	< 0.031	< 0.063	< 0.031	< 0.063	< 0.063	< 0.0147 J	< 0.0143 J	ND	0.0068 J	< 0.016	0.0088 J	< 0.00063	0.00073 J	< 0.00031	< 0.031	0.0118	< 0.079	
1,4-DICHLOROBENZENE	mg/L	ND	0.0982	0.0822 J	0.102 J	0.0705 J	0.0541 J	0.101 J	0.123 J	0.0866 J	ND	0.0401	0.0317 J	0.0051	< 0.0006	0.0045	< 0.0003	0.0847 J	0.0647	< 0.075	
1,4-DIOXANE (P-DIOXANE)	mg/L	--	< 3.6	< 7.3	< 15	< 7.3	< 15	< 15	< 0.073 J	< 0.073 J	--	< 0.73	< 3.6	< 0.15	< 0.15	< 0.15	< 0.073	< 7.3	< 0.73	< 18	
2-CHLOROTOLUENE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
4-CHLOROTOLUENE	mg/L	ND	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	
2-HEXANONE	mg/L	ND	< 0.085	< 0.17	< 0.34	< 0.17	< 0.17</td														

Table 6

SPLP Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - SPLP Results

Location		CAISSON 2										CAISSON 3											
Sample Date		11/12/2013	5/19/2014	5/27/2014						6/4/2014						5/28/2014						5/30/2014	6/4/2014
Treatment Stage		PRE THERMAL (RAW TAR)		POST THERMAL						POST REMOVAL						POST THERMAL (PRE ISS MIXING)						POST 1st MIX	POST 2nd MIX
Core/Depth	Parameter	Unit	0-1.2'	0-0.1'	A - 0-2'	A - 5-7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	Sample A	Sample B	0-0.1'	A - 0.8-2.2'	A - 7-8.2'	B - 0.9-1.6'	B - 5-7.6'	C - 4-5'	C - 5-7'	A - 6-8'	B - 6-8'	Sample C	
TETRACHLOROETHYLENE (PCE)	mg/L	ND	< 0.013	< 0.025	< 0.05	< 0.025	< 0.025	< 0.05	< 0.05	0.00028 J	0.00036 J	ND	< 0.0025	< 0.013	< 0.0005	< 0.0005	< 0.0005	< 0.00025	< 0.025	< 0.0025	< 0.0025	< 0.063	
TOLUENE	mg/L	43.3	21.6	10	28.4	6.99	6.04	18.8	17.4	19.4	24.8	47.9	1.09	1.66	0.14	0.0323	0.0755	0.0075	16.7	12.8	8.95		
TRANS-1,2-DICHLOROETHENE	mg/L	ND	< 0.019	< 0.038	< 0.076	< 0.038	< 0.038	< 0.076	< 0.076	< 0.00038 J	< 0.00038 J	ND	< 0.0038	< 0.019	< 0.00076	< 0.00076	< 0.00076	< 0.00038	< 0.038	< 0.0038	< 0.095		
TRANS-1,3-DICHLOROPROPENE	mg/L	ND	< 0.01	< 0.021	< 0.041	< 0.021	< 0.021	< 0.041	< 0.041	< 0.00021 J	< 0.00021 J	ND	< 0.0021	< 0.01	< 0.00041	< 0.00041	< 0.00041	< 0.00021	< 0.021	< 0.0021	< 0.052		
TRANS-1,4-DICHLORO-2-BUTENE	mg/L	ND	--	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--		
TRICHLOROETHYLENE (TCE)	mg/L	ND	< 0.025	< 0.051	< 0.1	< 0.051	< 0.051	< 0.1	< 0.1	< 0.00051 J	< 0.00051 J	ND	< 0.0051	< 0.025	< 0.001	< 0.001	< 0.00051	< 0.051	< 0.0051	< 0.13			
TRICHLOROFLUOROMETHANE	mg/L	ND	< 0.017	< 0.033	< 0.067	< 0.033	< 0.033	< 0.067	< 0.067	< 0.00033 J	< 0.00033 J	ND	< 0.0033	< 0.017	< 0.00067	< 0.00067	< 0.00067	< 0.00033	< 0.033	< 0.0033	< 0.084		
VINYL ACETATE	mg/L	ND	--	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--			
VINYL CHLORIDE	mg/L	ND	< 0.026	< 0.051	< 0.1	< 0.051	< 0.051	< 0.1	< 0.1	< 0.00051 J	< 0.00051 J	ND	< 0.0051	< 0.026	< 0.001	< 0.001	< 0.00051	< 0.051	< 0.0051	< 0.13			
Xylenes	mg/L	ND	3.7	2.19	3.9	2.14	2.07	3.26	3.8	3.61	3.89	ND	0.525	1.09	0.0977	0.0165	0.052	0.0018	2.47	2.07	1.6		
SPLP SVOCs																							
1,2,4,5-TETRACHLOROBENZENE	mg/L	ND	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	ND	< 0.00051	< 0.00036	< 0.00035	< 0.00036	< 0.00035	< 0.00034	< 0.00031	< 0.00032	< 0.00031		
1,2-DIPHENYLYHDRAZINE/AZOBENZEN	mg/L	ND	--	--	--	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--		
2,2-OXYBIS(2-CHLOROPROPANE)	mg/L	--	< 0.00045	< 0.00045	< 0.00045	< 0.00045	< 0.00045	< 0.00045	< 0.00045	< 0.00045	< 0.00045	--	< 0.00076	< 0.00054	< 0.00053	< 0.00053	< 0.00052	< 0.00051	< 0.00045	< 0.00048	< 0.00045		
2,3,4,6-TETRACHLOROPHENOL	mg/L	--	< 0.00094	< 0.00094	< 0.00094	< 0.00094	< 0.00094	< 0.00094	< 0.00094	< 0.00094	< 0.00094	--	< 0.0016	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.00094	< 0.00094	< 0.00094			
2,4,5-TRICHLOROPHENOL	mg/L	ND	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	ND	< 0.0026	< 0.0019	< 0.0018	< 0.0018	< 0.0018	< 0.0016	< 0.0016	< 0.0016			
2,4,6-TRICHLOROPHENOL	mg/L	ND	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	< 0.0013	ND	< 0.0022	< 0.0015	< 0.0015	< 0.0015	< 0.0014	< 0.0013	< 0.0014	< 0.0013			
2,4-DICHLOROPHENOL	mg/L	ND	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	< 0.0012	ND	< 0.019	< 0.0014	< 0.0013	< 0.0013	< 0.0012	< 0.0012	< 0.0012	< 0.0012			
2,4-DIMETHYLPHENOL	mg/L	ND	0.122	0.18	0.275	0.189	0.147	0.151	0.227	0.0252	0.125	ND	0.0939	0.063	0.0159	0.0031 J	0.0118	< 0.0017	0.15	0.0856	0.0297		
2,4-DINITROPHENOL	mg/L	ND	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	ND	< 0.028	< 0.02	< 0.019	< 0.019	< 0.019	< 0.017	< 0.017	< 0.017			
2,4-DINITROTOLUENE	mg/L	ND	< 0.00043	< 0.00043	< 0.00043	< 0.00043	< 0.00043	< 0.00043	< 0.00043	< 0.00043	< 0.00043	ND	< 0.00071	< 0.00051	< 0.0005	< 0.00048	< 0.00048	< 0.00043	< 0.00045	< 0.00043			
2,6-DINITROTOLUENE	mg/L	ND	< 0.00046	< 0.00046	< 0.00046	< 0.00046	< 0.00046	< 0.00046	< 0.00046	< 0.00046	< 0.00046	ND	< 0.00077	< 0.00055	< 0.00054	< 0.00054	< 0.00052	< 0.00052	< 0.00046	< 0.00046			
2-CHLORONAPHTHALENE	mg/L	ND	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	ND	< 0.0005	< 0.00035	< 0.00035	< 0.00035	< 0.00034	< 0.00033	< 0.00031	< 0.0003			
2-CHLOROPHENOL	mg/L	ND	< 0.00097	< 0.00097	< 0.00097	< 0.00097	< 0.00097	< 0.00097	< 0.00097	< 0.00097	< 0.00097	ND	< 0.0016	< 0.0012	< 0.0011	< 0.0011	< 0.0011	< 0.00097	< 0.00097	< 0.00097			
2-METHYLNAPHTHALENE	mg/L	0.0506 J	0.037	0.0355	0.0407	0.0344	0.0149	0.0322	0.0374	0.0039	0.0225	0.124 J</td											

Table 6

SPLP Results

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Impoundment Xtab - SPLP Results

Location		CAISSON 2									
Sample Date		11/12/2013	5/19/2014	5/27/2014					6/4/2014		
Treatment Stage		PRE THERMAL (RAW TAR)		POST THERMAL					POST REMOVAL		
Core/Depth	0-1.2'	0-0.1'	A - 0-2'	A - 5-7'	B - 0-2.7'	B - 2.7-5'	B - 8-10'	C - 1-3.2'	Sample A	Sample B	
Parameter	Unit	112113-TAR- TC02-00012	051914-TAR- TC02A-000001	052714-HC- TC02A-050070	052714-HC- TC02B-000027	052714-HC- TC02B-027050	052714-HC- TC02B-	052714-TAR- TC02C-010032	060414-TAR- TC02A	060414-TAR- TC02B	
N-NITROSODIPHENYLAMINE	mg/L	ND	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	< 0.00031	
N-NITROSODIMETHYLAMINE	mg/L	ND	--	--	--	--	--	--	--	--	
PYRIDINE	mg/L	0.398	--	--	--	--	--	--	--	--	
PHENOL	mg/L	0.119 J	0.0581	0.255	0.254	0.067	0.0552 J	0.0952	0.131	0.0108	0.0786 J
SPLP PAHs											
ACENAPHTHENE	mg/L	--	0.00443 J	0.00313	0.00311	0.00298	0.00293	0.0035	0.00337	0.000505	0.00247 J
ACENAPHTHYLENE	mg/L	ND	< 0.000024	< 0.000024	< 0.000024	< 0.000024	< 0.000024	< 0.000024	< 0.000024	< 0.000024	< 0.000024
ANTHRACENE	mg/L	ND	0.00046	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
BENZO(A)ANTHRACENE	mg/L	ND	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012
BENZO(A)PYRENE	mg/L	ND	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012
BENZO(B)FLUORANTHENE	mg/L	ND	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
BENZO(G,H,I)PERYLENE	mg/L	ND	< 0.000016	< 0.000016	< 0.000016	< 0.000016	< 0.000016	< 0.000016	< 0.000016	< 0.000016	< 0.000016
BENZO(K)FLUORANTHENE	mg/L	ND	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015
CHRYSENE	mg/L	ND	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012	< 0.000012
DIBENZ(A,H)ANTHRACENE	mg/L	ND	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017 J	< 0.000017	< 0.000017 J	< 0.000017	< 0.000017
FLUORANTHENE	mg/L	ND	0.000119	< 0.000013	< 0.000013	< 0.000013	< 0.000013	< 0.000013	0.000113	< 0.000013	< 0.000013
FLUORENE	mg/L	0.0598 J	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017
HEXACHLOROBENZENE	mg/L	ND	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017	< 0.000017
INDENO(1,2,3-C,D)PYRENE	mg/L	ND	< 0.000014	< 0.000014	< 0.000014	< 0.000014	< 0.000014 J	< 0.000014	< 0.000014 J	< 0.000014	< 0.000014
NAPHTHALENE	mg/L	ND	--	--	--	--	--	--	--	--	--
PENTACHLOROPHENOL	mg/L	ND	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001 J	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PHENANTHRENE	mg/L	ND	0.00147	0.000425	0.000423	0.000407	0.000521	0.000441	0.000214	0.000319	
PYRENE	mg/L	ND	0.000019	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	< 0.000015	
SPLP Metals											
ALUMINUM	mg/L	--	--	4.33	11	4.88	15.2	13	5.55	9.07	7.81
ANTIMONY	mg/L	--	--	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	< 0.0026	
ARSENIC	mg/L	ND	0.0162	0.0954	0.0909	< 0.026	0.0454	< 0.051	< 0.026	< 0.026	< 0.026
BARIUM	mg/L	0.0077 J	0.0295 J	0.0252 J	0.0308 J	0.0336 J	0.0328 J	0.0315 J	0.0324 J	0.0324 J	0.0316 J
BERYLLIUM	mg/L	--	--	0.0004 J	0.0005 J	< 0.0004	0.0008 J	0.001 J	0.0004 J	0.0019 J	0.0019 J
CADMIUM	mg/L	ND	0.0008 J	0.0014 J	< 0.0014	0.0025 J	0.0029 J	< 0.0014	< 0.0007	0.0036 J	0.004 J
CALCIUM	mg/L	--	--	3.89 J	10.9	3.59 J	7.29 J	7.31 J	4.57 J	5.22 J	5.88 J
CHROMIUM, TOTAL	mg/L	0.021	0.77	0.697 J	1.26	0.392	0.753	1.24	0.536	0.864	0.941
COBALT	mg/L	--	--	0.0207 J	0.0384 J	0.01 J	0.0317 J	0.0147 J	0.0101 J	0.0183 J	0.0149 J
COPPER	mg/L	--	--	0.492	0.646	0.0773	0.0198	0.0161 J	0.139	0.229	0.101
IRON	mg/L	--	--	344	579	208	260	622	271	365	413
LEAD	mg/L	0.13	0.487	0.91	1.05	0.596	0.967	0.447	0.644	0.848	0.625
MAGNESIUM	mg/L	--	--	1.41 J	5.25 J	1.03 J	2.12 J	2.86 J	1.48 J	1.67 J	1.59 J
MANGANESE	mg/L	--	--	4.5	6.09	1.94	2.37	6.39	2.86	3.72	4.19
MERCURY	mg/L	0.0001 J	< 0.000064	< 0.000064	< 0.000019	0.00032 J	0.00022 J	< 0.000064	0.00011 J	< 0.000064	0.000079 J
NICKEL	mg/L	--	--	1.38	1.32	0.232	0.423	0.491	0.314	0.636	0.458
POTASSIUM	mg/L	--	--	2.4 J	5.9 J	2.83 J	8.39 J	7.48 J	3.16 J	4.87 J	4.43 J
SELENIUM	mg/L	< 0.031	0.0118 J	< 0.0036	0.0111 J	0.0237 J	0.0318 J	< 0.0073	< 0.0036	< 0.0036	< 0.0036
SILVER	mg/L	0.0053 J	0.0179	0.0166 J	0.0297	0.0241	0.026	0.0306	0.0141	< 0.0012	< 0.0012
SODIUM	mg/L	--	--	70	124	63.1	153	156	78.5	99.5	99
THALLIUM	mg/L	--	--	< 0.0092	< 0.037	< 0.018	< 0.018	< 0.037	< 0.018	< 0.018	< 0.018
VANADIUM	mg/L	--	--	0.121	0.111	0.027 J	0.0392 J	0.0567	0.039 J	0.0644	0.0641
ZINC	mg/L	--	--	0.324	0.544	2.91	0.45	0.29	0.234	0.296	0.24

11/12/2013		CAISSON 3						
PRE THERMAL (RAW TAR)		POST THERMAL (PRE ISS MIXING)						
<th colspan

Table 7

Physical Properties Testing

OU 8 Pilot Study ISTT Memorandum, American Cyanamid Superfund Site, Bridgewater, NJ

Sample Number	Stage	Cure Interval	Unconfined Compressive Strength ASTM D2166					Hydraulic Conductivity (k) (cm/sec) ASTM D5084					Loss on Ignition (Organic Content) ASTM D2974							Average	
			ASTM Moisture Content (%)	EPA Moisture Content (%)	Bulk Density (lb/ft³)	Dry Density (lb/ft³)	UCS (lb/in²)	ASTM Moisture Content (%)	EPA Moisture Content (%)	Bulk Density (lb/ft³)	Dry Density (lb/ft³)	Hydraulic Conductivity (cm/sec)	Average ASTM Moisture Content (%)	Average EPA Moisture Content (%)	Average ASTM Moisture Content (DUP) (%)	Average EPA Moisture Content (DUP) (%)	Average Loss on Ignition (Mass %)	Average Loss on Ignition (DUP)	Average Loss on Ignition (DUP)	EPA Moisture Content (%)	
Raw Tar Sample																					
IMP2 - HC - Homogenized	Bench-Scale Test	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A	VE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Caisson #1 (ISS Only)																					
053014-TAR-TC01A-060080	Post ISS	28 Day	43.3	30.2	90.0	62.8	120.9	39.8	28.5	91.7	65.5	1.40E-08	51.9	34.1	48.4	32.6	29.1	28.1	31.4		
		56 Day	44.3	30.7	93.3	64.7	249.0	43.4	30.3	91.4	63.8	1.50E-07							31.9		
060514-TAR-TC01B	Post S/S	28 Day	67.57	40.3	86.2	51.5	16.0	67.0	40.1	84.2	50.4	1.10E-05	64.36	39.2	65.91	39.7	20.09	20.28	39.8		
		56 Day	62.72	38.6	81.1	49.9	33.9	69.2	40.9	84.3	49.8	8.50E-06							39.6		
Caisson #2 (ISTT Only)																					
052714-TAR-TC02B-0080090	Post ISTT	N/A	37.2	27.1	83.3	60.7	148.1	16.0	13.8	83.7	72.7	7.40E-06	26.5	21.0			59.0			20.6	
052714-TAR-TC02C-090100	Post ISTT	N/A	28.9	22.4	72.8	56.5	23.1	27.5	21.6	76.4	59.9	3.20E-05	24.5	19.7	27.9	21.8	80.5	80.1	21.4		
Caisson #3 (ISTT/ISS)																					
05281-TAR-TC03C-030040	Post ISTT	N/A	50.4	33.5	82.2	54.7	9.1	50.2	33.4	80.4	53.5	3.40E-04	50.3	33.5			29.3			33.5	
052814-TAR-TC03C-040050	Post ISTT	N/A	46.6	31.8	85.7	58.5	56.2	45.7	31.4	84.6	58.1	3.20E-05	51.6	34.0	50.2	33.4	31.9	31.5	32.7		
052914-TAR-TC03-000080	Post ISS	28 Day	81.7	45.0	80.7	44.4	62.8	73.0	42.2	85.1	49.2	1.60E-06	97.9	49.4	93.3	48.2	31.5	32.8	46.2		
		56 Day	90.0	47.4	83.2	43.8	167.7	93.2	48.2	78.7	40.7	3.50E-07							48.3		
060414-TAR-TC03C	Post S/S	28 Day	60.8	37.8	85.7	53.3	224.5	54.6	35.3	83.7	54.1	2.90E-07	62.66	38.6	59.44	37.3	18.54	19.66	37.3		
		56 Day	62.3	38.4	86.2	53.1	197.5	60.4	37.6	86.0	53.6	8.70E-08							38.0		

Notes:

% = percent

lb/ft³ = pounds per square feet

lb/in² = pounds per square inch

cm/sec = centimeter per seconds

ASTM Moisture Content=Weight of Water/Dry Weight of Sample

EPA Moisture Content=Weight of Water/Wet Weight of Sample

N/A= Not applicable, Sample would not compact for UCS Testing

ISS = In-Situ Stabilization/Solidification

ISTT = In-Situ Thermal Treatment

S/S = Stabilization/Solidification (ex-situ)

VE = volatiles expanded causing material to expand becoming untestable.

Figures

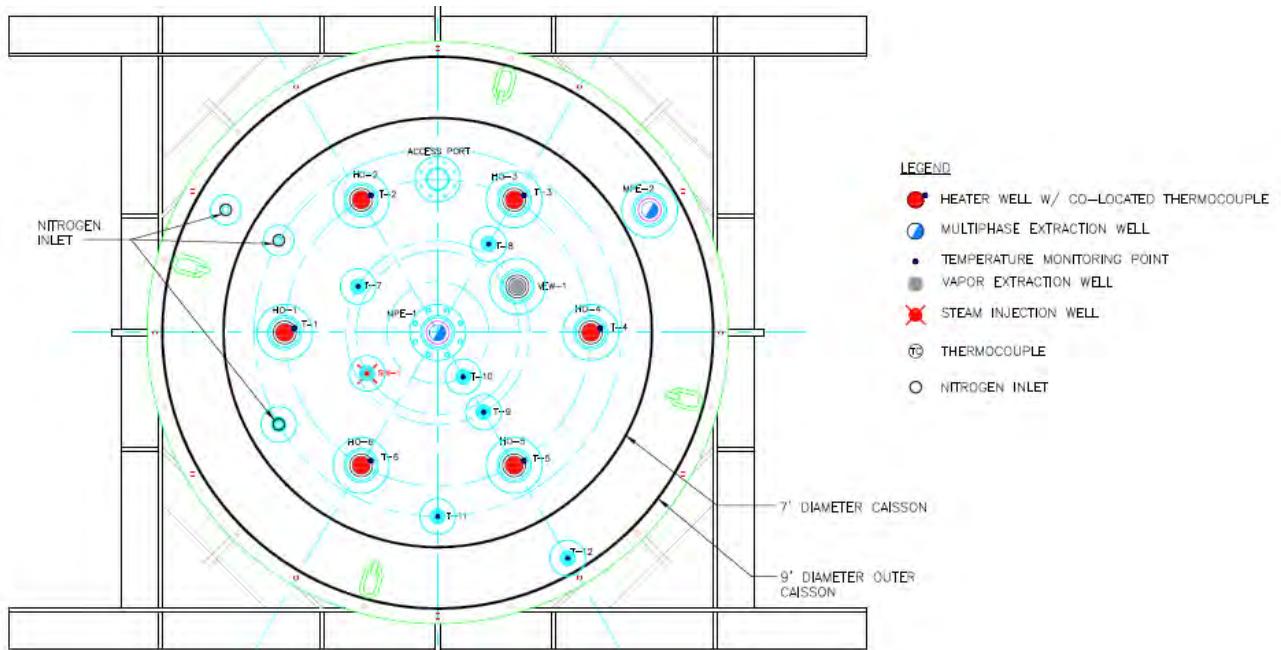
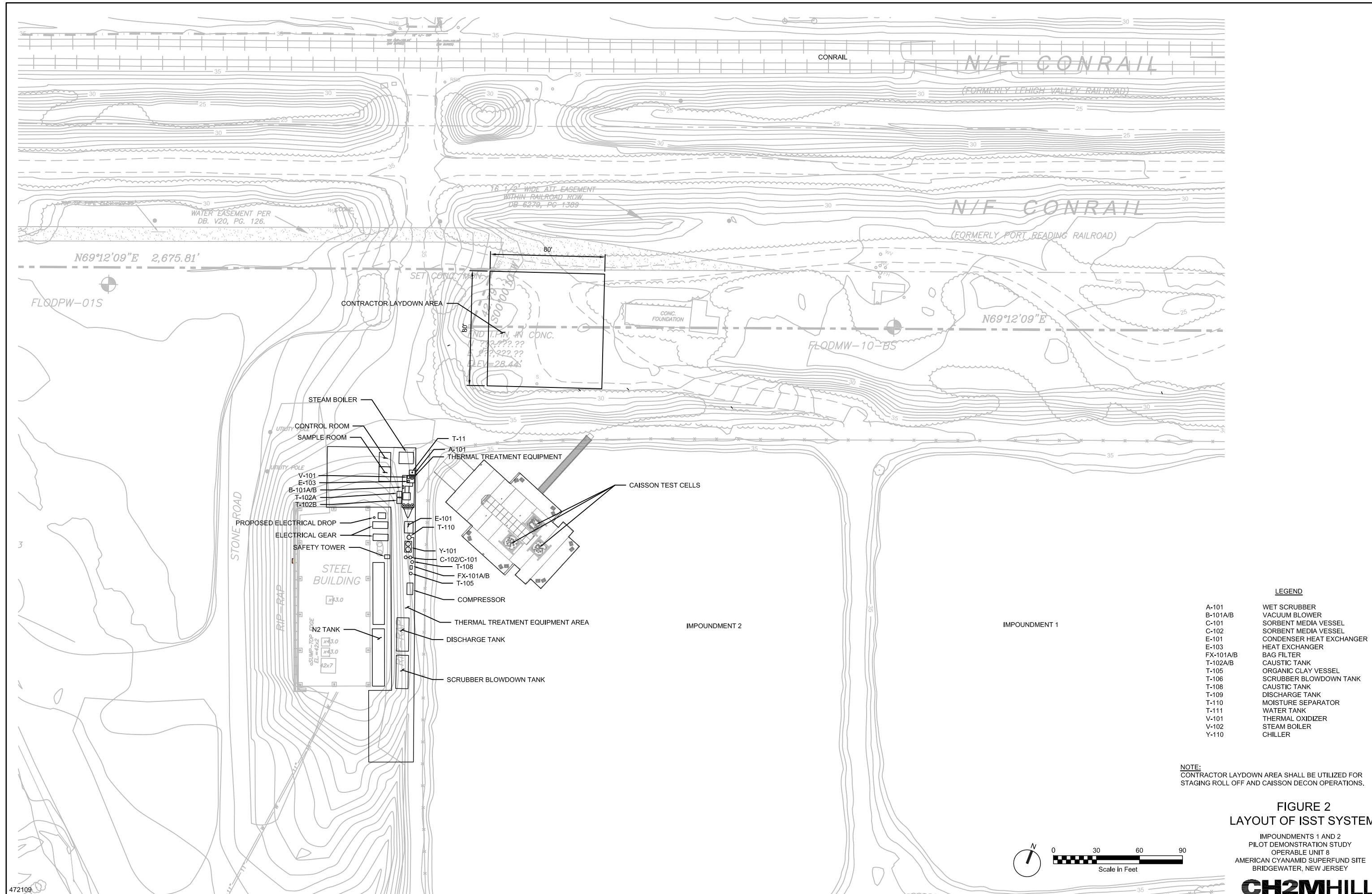


FIGURE 1
ISTT Caisson Configuration
In-situ Thermal Treatment Summary



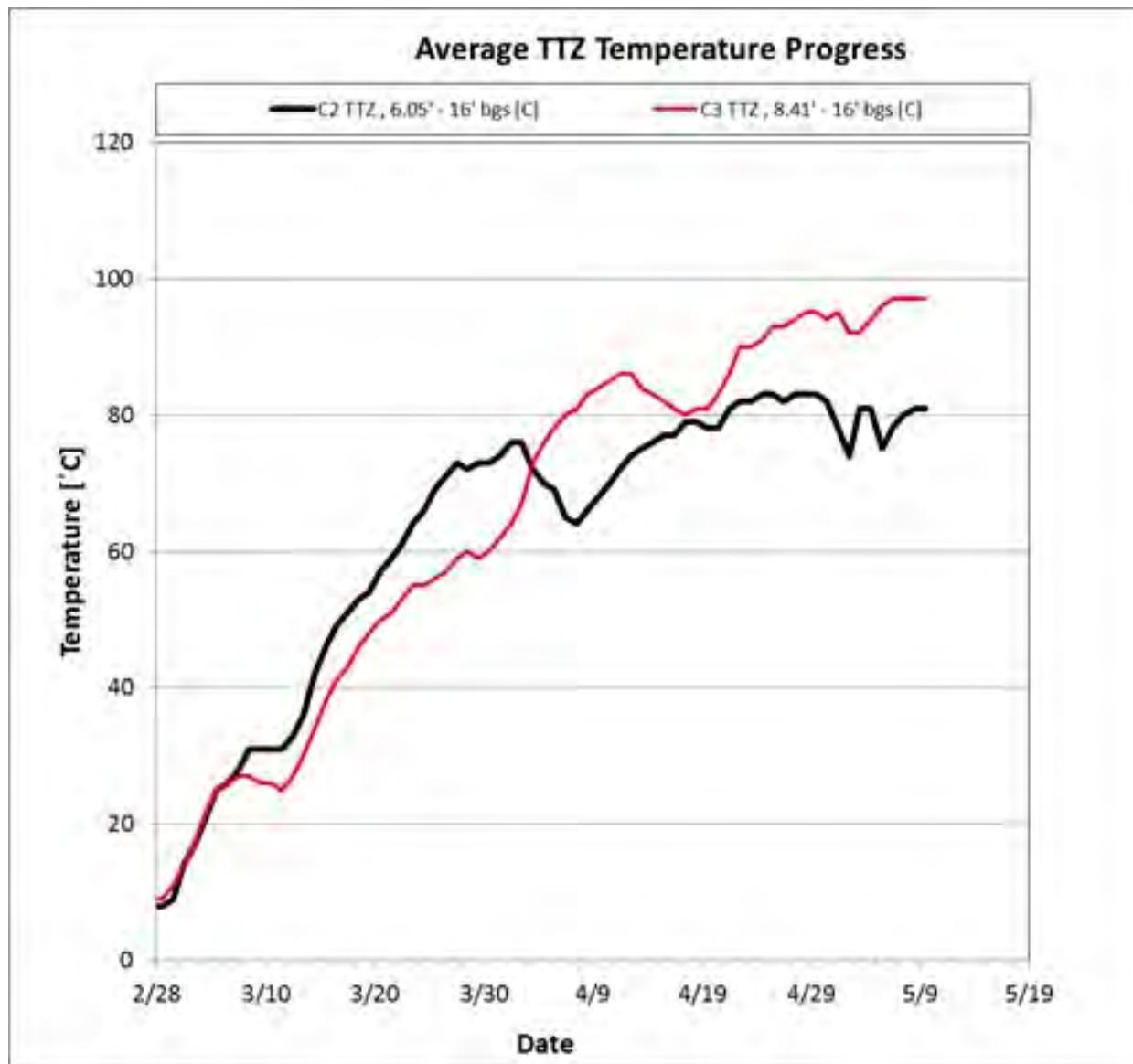


FIGURE 3
Average Caisson Treatment Zone Temperatures
In-situ Thermal Treatment Summary

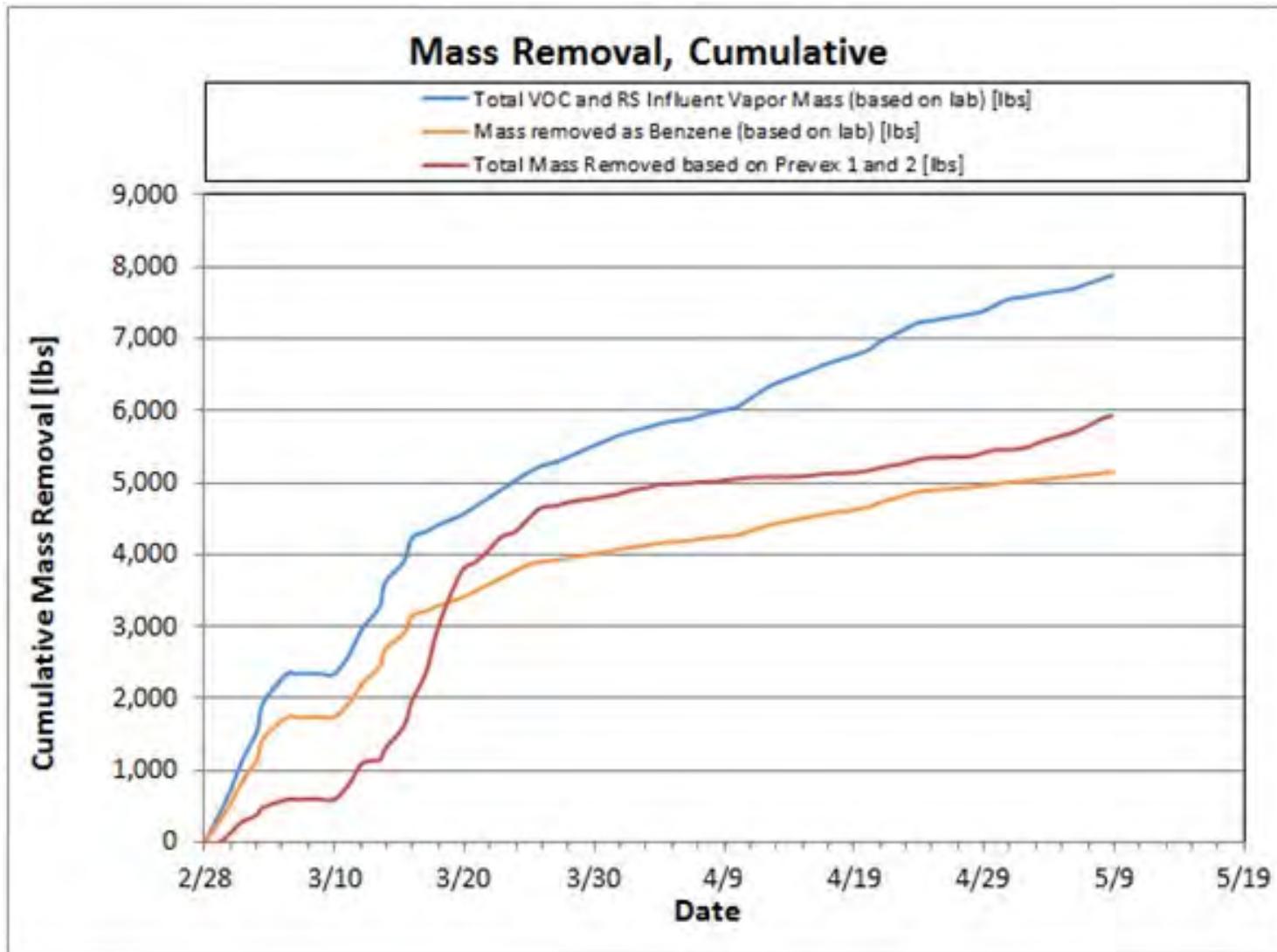


FIGURE 4
Mass Removal Summary
In-situ Thermal Treatment Summary

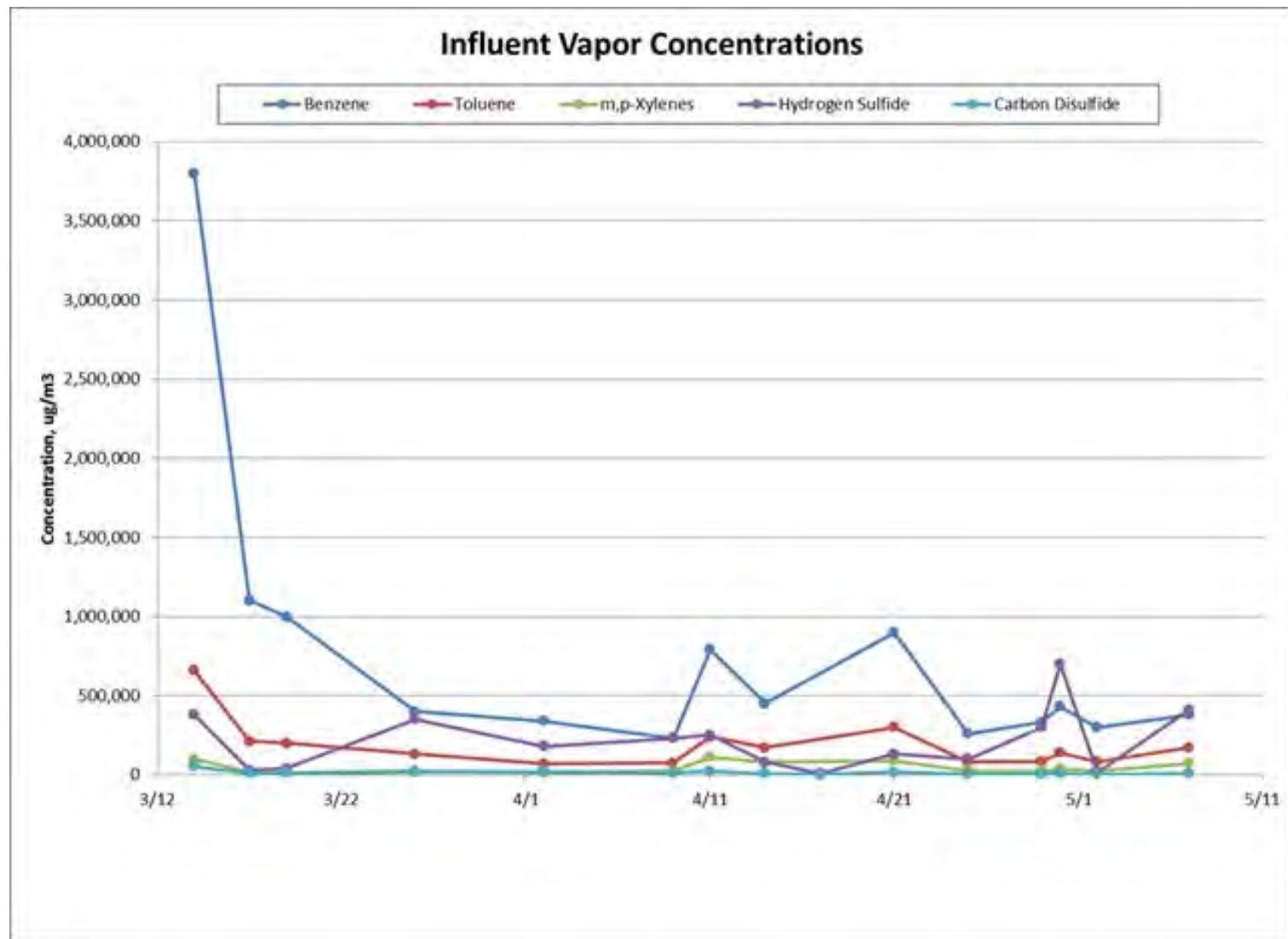


FIGURE 5
Thermal Oxidizer Influent Sample Concentrations
In-situ Thermal Treatment Summary

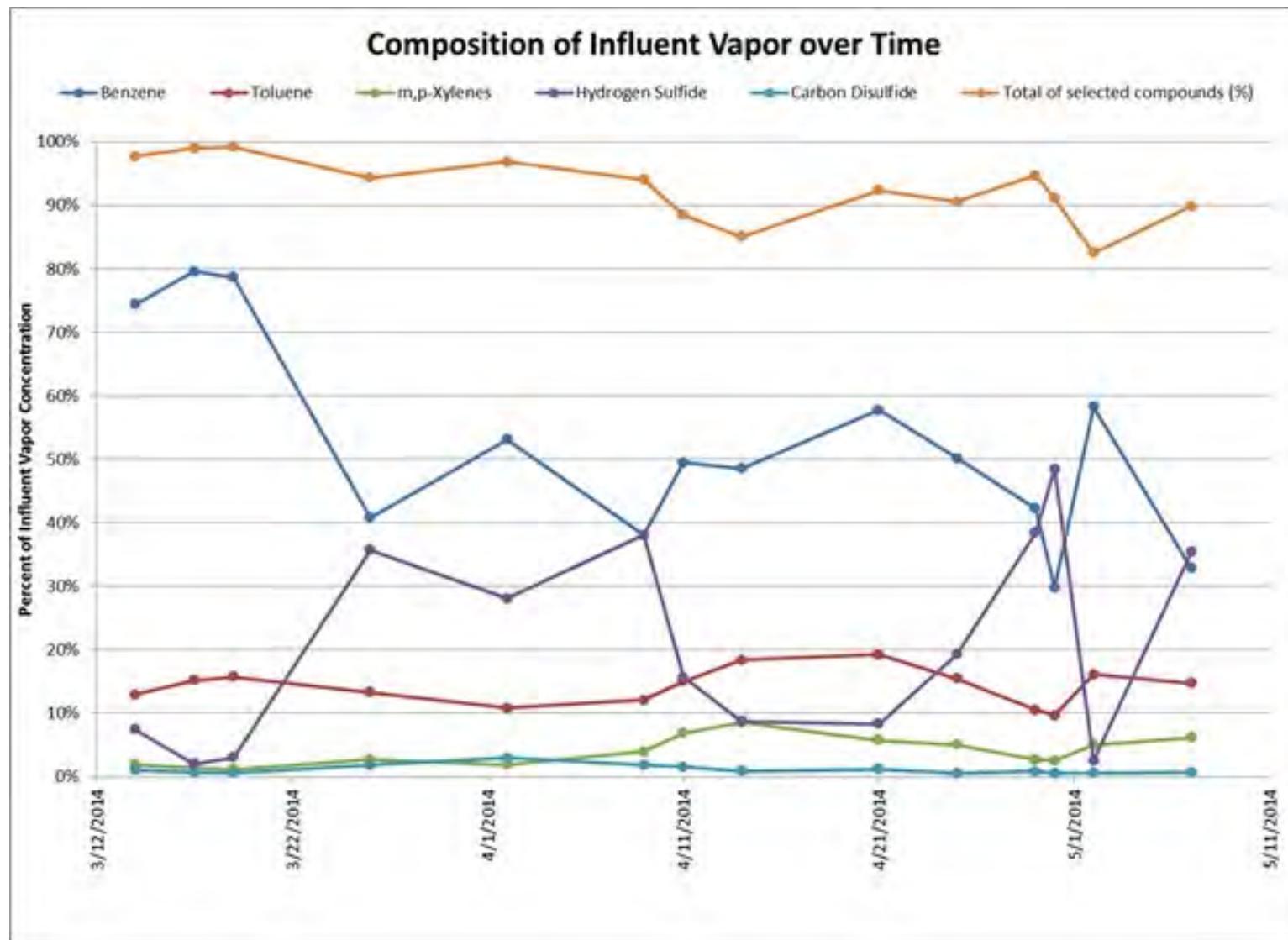


FIGURE 6
Composition of Influent Vapor Over Time
In-situ Thermal Treatment Summary

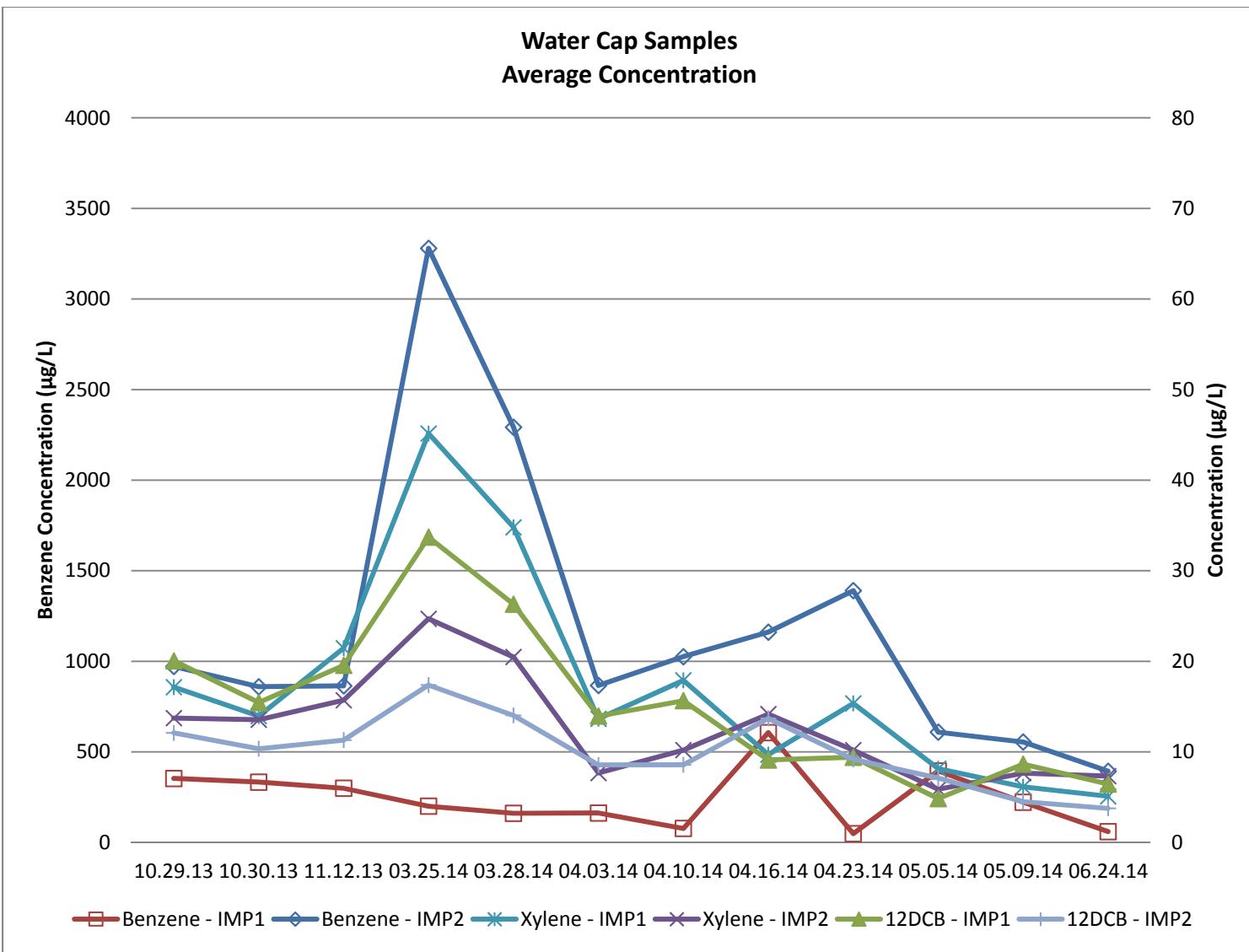


FIGURE 7
Summary of Water Cap Results
In-situ Thermal Treatment Summary

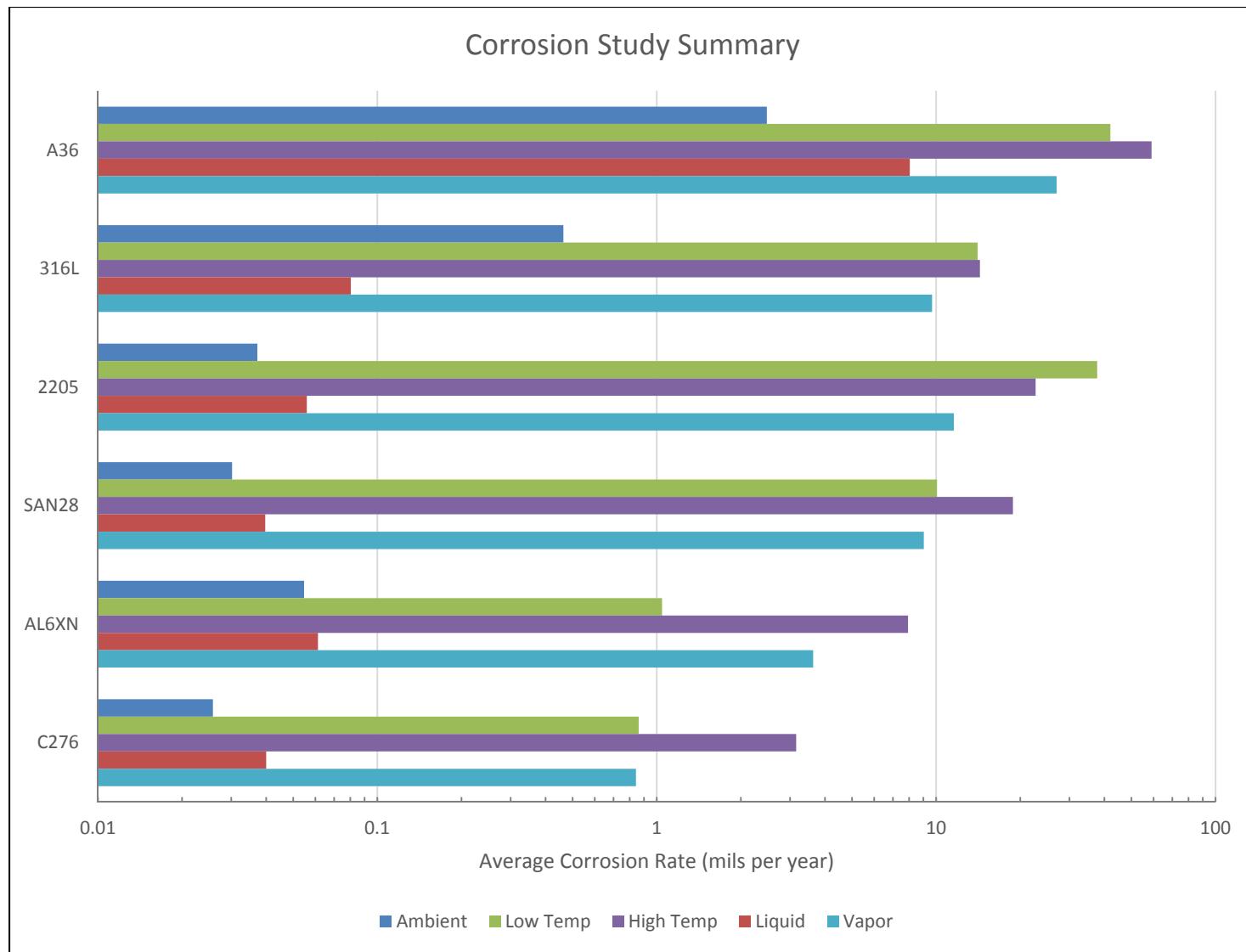


FIGURE 8
Corrosion Study Summary Results
In-situ Thermal Treatment Summary

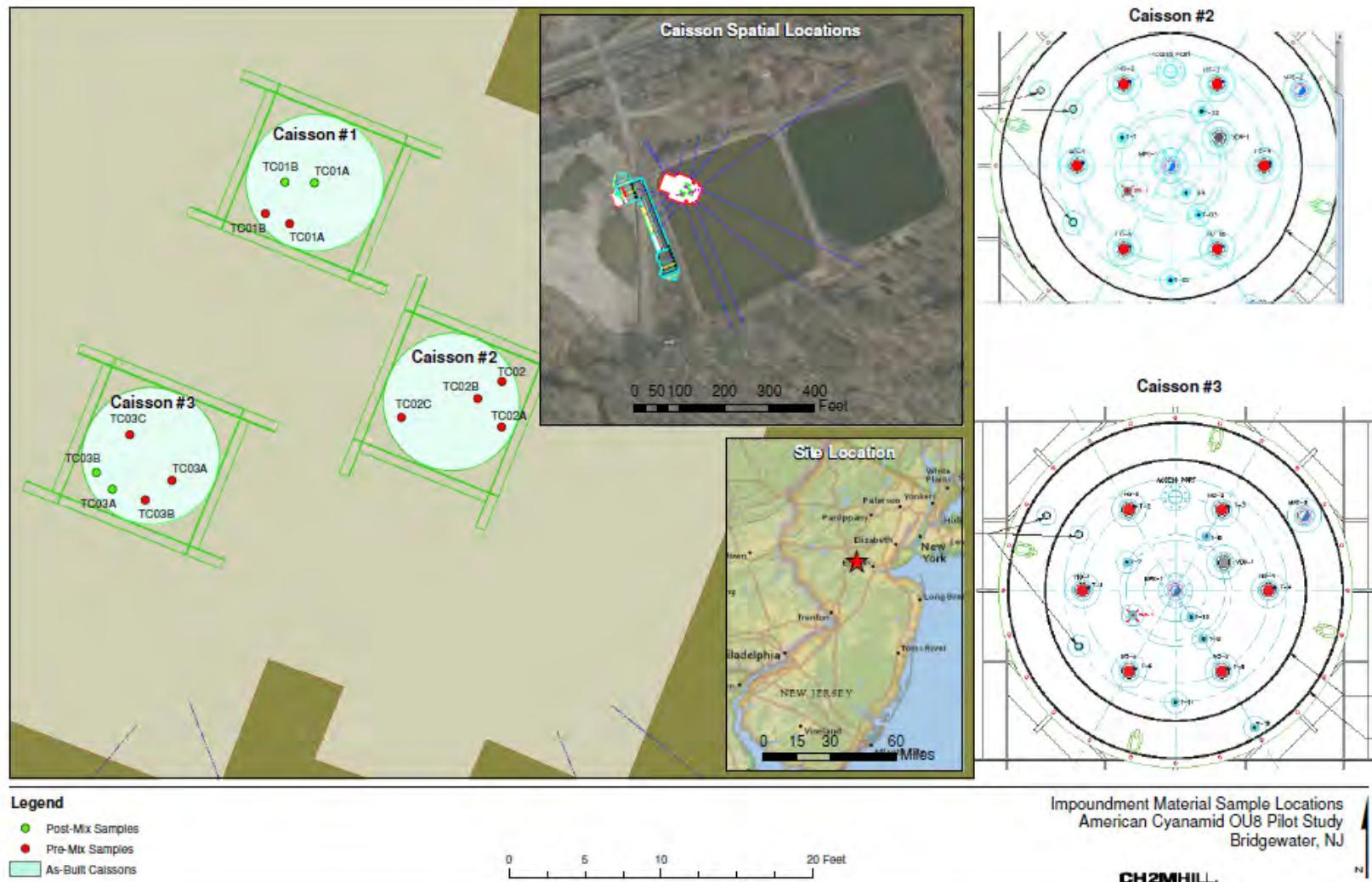


FIGURE 9
Impoundment Material Sample Locations
In-situ Thermal Treatment Summary

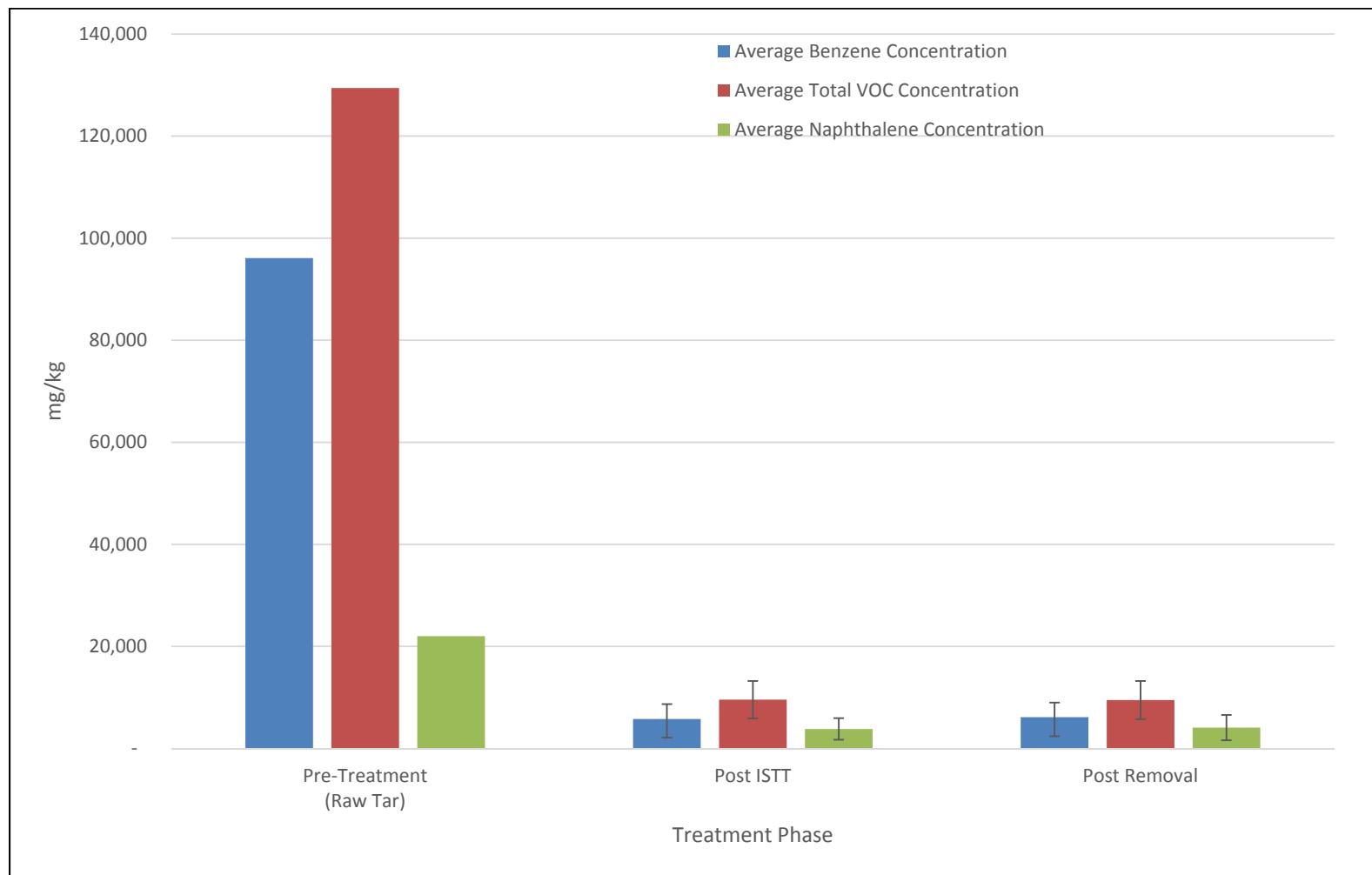


FIGURE 10
Caisson 2 Average Concentrations Over Time
In-situ Thermal Treatment Summary

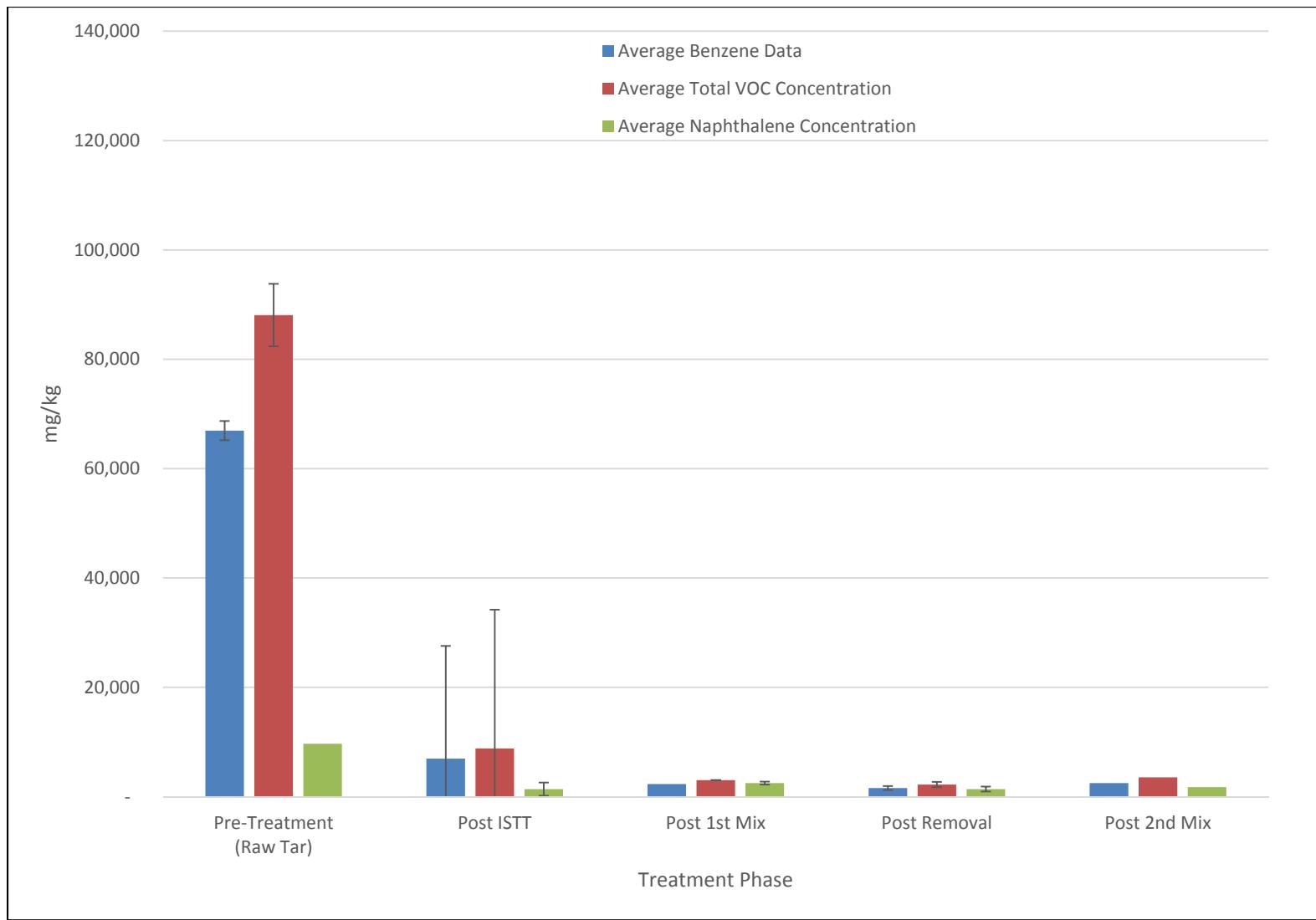


FIGURE 11
Caisson 3 Average Concentrations Over Time
In-situ Thermal Treatment Summary

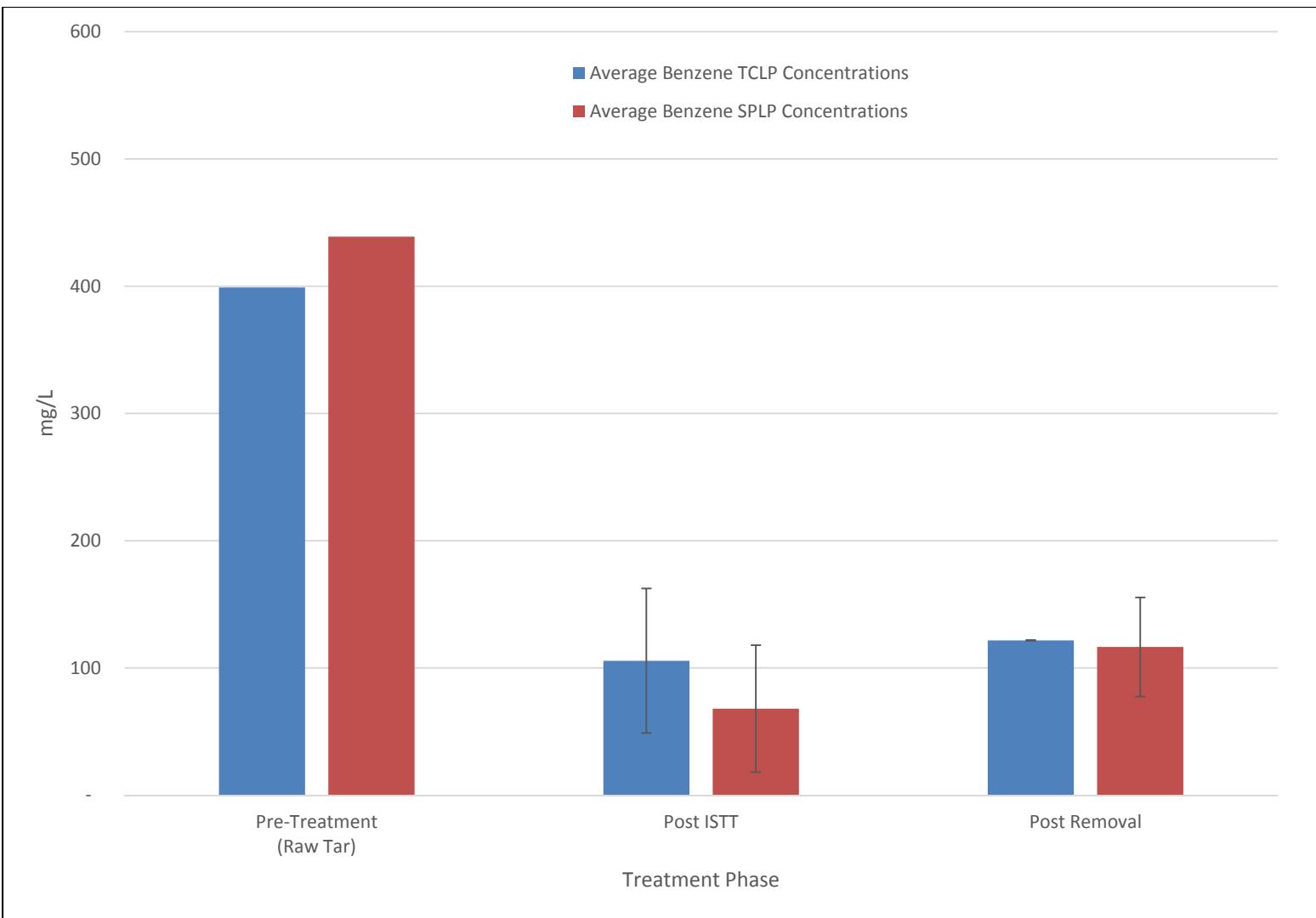


FIGURE 12
Caisson 2 Benzene TCLP and SPLP Results
In-situ Thermal Treatment Summary

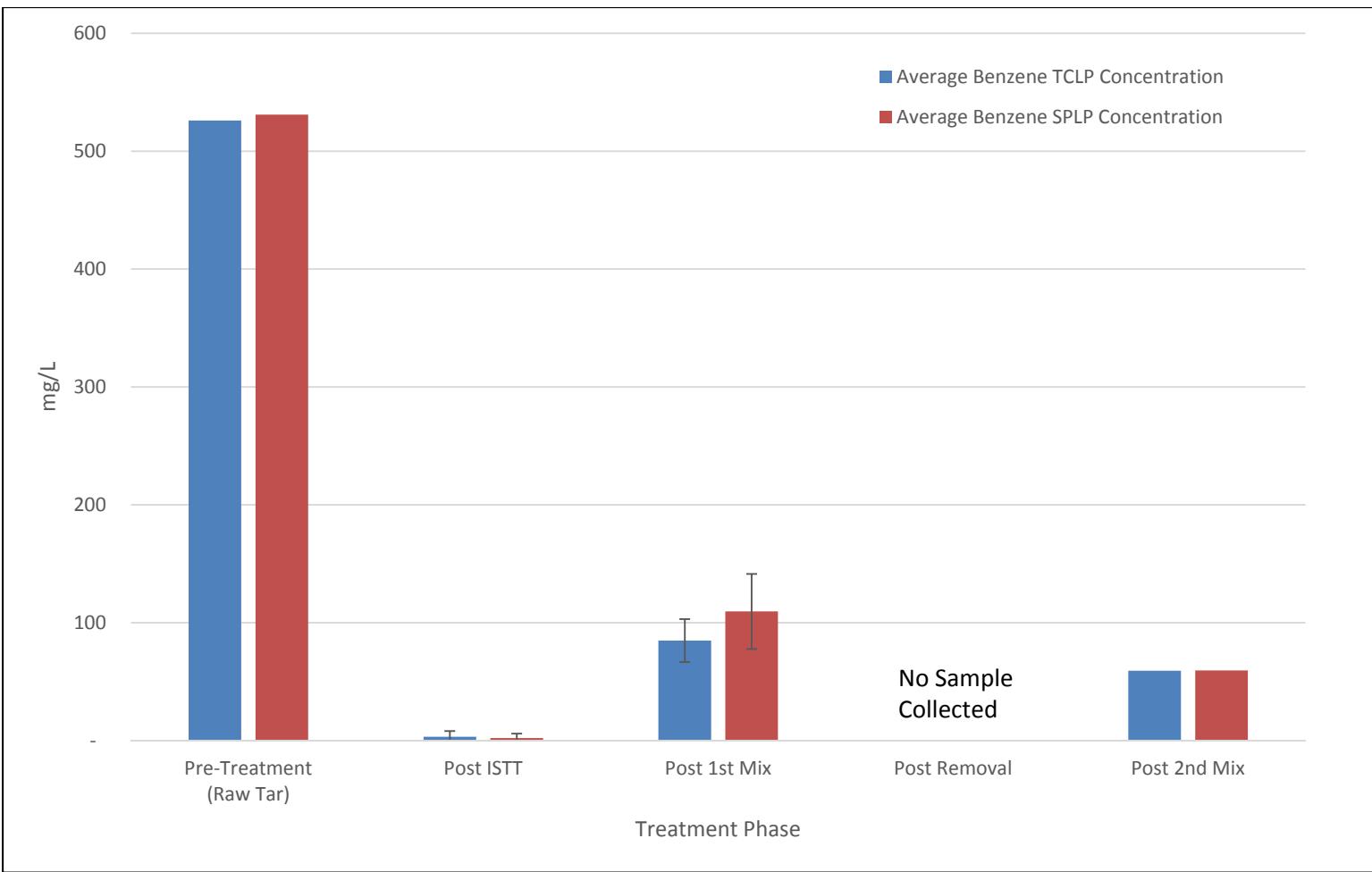


FIGURE 13
Caisson 3 Benzene TCLP and SPLP Results
In-situ Thermal Treatment Summary